ROADS And STREETS
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Where 95th St. Crosses the Tracks of the New York Central, Chicago & Western Indiana, and New York, Chicago & St. Louis Railroads Just West of Stony Island Ave.
One of Some 12 Locations in Cook County at Which Important Separations of Railways and Highways are Under Construction. (*Photo April* 30, 1935.)

RECENT RAILWAY AND HIGHWAY GRADE SEPARATIONS IN COOK COUNTY, ILLINOIS

HIGHWAY safety and convenience in and near Chicago, the world's greatest railroad center, are being conspicuously improved at the present time by the elimination of numerous grade crossings. About a dozen such jobs are in progress and others are pending. Many more separations, however, must be made in order to establish conditions which the motoring public may reasonably ask.

Herewith are presented pictures and condensed cost statements of a number of these separations which have been made in the recent past or are now nearing completion. Two of them were Cook County jobs, and the others were done by the State of Illinois. All were constructed by contract; and all are within Cook County.

It is the practice of the Illinois Division of Highways to furnish the cement for all such work, this system being considered by the department heads to afford several advantages, including that of maximum economy. Concrete prices, therefore, are usually shown exclusive of the cement item. In a few instances, however, a contrary practice was followed. In all cases the inclusion or the exclusion of cement is clearly stated.

Costs per square foot of horizontal area have been computed in order to provide a single approximate unit cost for each structure. They vary widely according to foundation and other conditions.

It will be noted that concrete, steel and timber all have important places in this construction. Types and details are various, as evidenced by the pictures.

Cook County, in the main, is an area of poor natural drainage, and in several instances special pumping plants are necessary to keep the subways passable in wet weather. Pumps and motors at these installations are in duplicate, arranged to start and stop automatically as needed. Should either unit fail, the other will be immediately cut in by the control mechanism. The only attendance required is for oiling and general care once in several months. The crossing of Higgins Road under the Soo Line, here illustrated, has such an installation.

Earth slopes at many of the grade separations are being sodded and attractively planted with shrubs and small trees. In some instances the sidewalks of underpasses are raised to a considerable height above the roadway level with resulting economy and bettered appearance.

SOUTHWEST HIGHWAY (STATE ROUTE 7) OVER 3 EXISTING TRACKS AND LOCATION OF 4 PROPOSED TRACKS OF B. & O. C. T. RY. AT CHICAGO RIDGE

Upper Picture—General View.
Lower Picture—Track and Adjacent Spans —Plate Girder to Left, I Beam to Right of Steel Bent.

(Photos April 30, 1935)

23 *Reinforced concrete spans @ 50 ft. 0 in.*	1,150 *ft.* 0 *in.*
1 *Steel plate girder span*	63 *ft.* 10 *in.*
1 *Steel I beam span*	55 *ft.* 0 *in.*
Total length	1,268 *ft.* 10 *in.*
Roadway width	44 *ft.* 0 *in.*
1 *Sidewalk*	6 *ft.* 0 *in.*
Total width	50 *ft.* 0 *in.*
Horizontal area	63,442 *sq. ft.*

Contracts awarded March 14, 1934.

Cost of Substructure, Concrete Spans, I-Beam Span and Pavement

Channel excavation, 763 cu. yd. @ 0.75	$ 572
Backfill, 223.5 cu. yd. @ 2.50	559
4-in. concrete pavement, 5,586 sq. yd. @ 0.85 (not including cement)	4,748
8-in. floor and wall tile, 6,256 sq. ft. @ 0.20	1,251
Lighting conduit	1,347
Hand rail concrete, 164.1 cu. yd. @ 30.00 (not including cement)	4,923
Class A concrete, 102.9 cu. yd. @ 14.00 (not including cement)	1,441
Class X concrete, 6,799.8 cu. yd. @ 15.00 (not including cement)	101,997
Reinforcement bars, 1,349,420 lb. @ 0.03	40,483
Structural steel, 30,330 lb. @ 0.06	1,820
Rockers and plates, 77,472 lb. @ 0.055	4,261
Treated piles, 20 ft. and less furnished, 27,415 ft. @ 0.20	5,483
Treated piles, 20 to 35 ft. furnished, 3,152 ft. @ 0.60	1,891
Driving piles, 24,954 ft. @ 0.05	1,248
Name plate	15
Test piles, 9 @ 150.00	1,350
Floor drains, 278 @ 0.50	139
Wire fabric, 8,223 lb. @ 0.03	247
Cement, 12,904.25 bbl. @ 2.00	25,808
Extra work due to change in grade line	3,950
Painting structural steel (including p. g. span)	805
Miscellaneous items	687
Total Cost of Sub-structure, Concrete Spans, I-Beam Span and Pavement	$205,025

Cost of Plate Girder Span

Hand rail concrete, 11.3 cu. yd. @ 42.20 (not including cement)	$ 477
Class X concrete, 150.4 cu. yd. @ 18.40 (not including cement)	2,767
Reinforcement bars, 46,010 lb. @ 0.0286	1,316
Structural steel, 335,749 lb. @ 0.0389	13,061
Blast plates, 15,346 lb. @ 0.0444	681
Miscellaneous items	171
Cement, 276.5 bbl. @ 2.38	658
Total Cost of Plate Girder Span	$ 19,131
Total Cost of Bridge	$224,156

Cost per square foot horizontal area, $3.55.

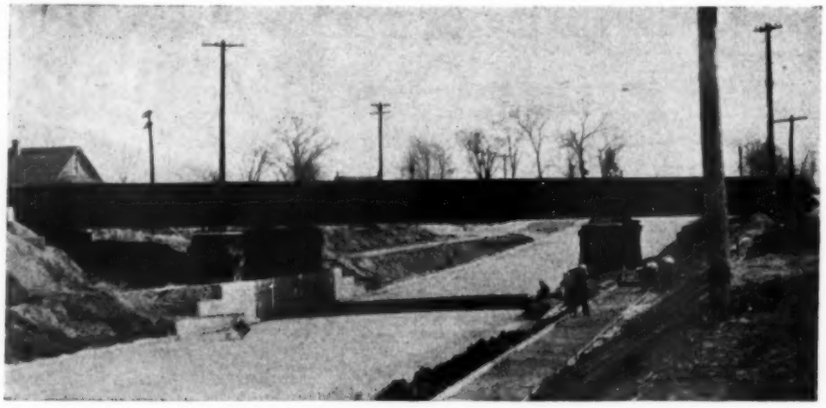
HIGGINS ROAD (U. S. ROUTE 14) UNDER 2 TRACKS OF THE SOO LINE, NEAR ORCHARD PLACE

(Photo April 20, 1935)

Plate girders on concrete abutments and creosoted pile piers; drainage by automatic equipment in pump house 500 ft. away.

Middle span girder	63 *ft.* 0 *in.*
2 *End girders, 34 ft. 1⅝ in. each*	68 *ft.* 3¼ *in.*
Total Girder Length	131 *ft.* 3¼ *in.*
Width of bridge—c. to c. of girders	21 *ft.*
Horizontal area	2,756 *sq. ft.*
Roadway width between curb faces	42 *ft.*
2 *Sidewalks, 5 ft. each*	10 *ft.*
Parked areas and slopes	48 *ft.*
Right of Way	100 *ft.*

Constructed 1934-1935.



Cost of Bridge

Temporary trestle	$ 350
Concrete, Class X, 100.8 cu. yd. @ 20.00 (not including cement)	2,016
Reinforcement bars, 17,107 lb. @ 0.0385	659
Structural steel in place and painted, 342,625 lb. @ 0.043	14,733
Creosoted piling, 3,805 lin. ft.	3,051
Pile driving, 2,497 lin. ft. @ 0.30	749
Concrete cribbing wall, 1,054 sq. ft. @ $3.10	3,267
Treated lumber, 14,299 f.b.m. @ 0.12 in place	1,716
Deck waterproofing, 3,762 sq. ft. @ 0.235	884
Ballast, 110 cu. yd. @ 2.95	324
Cement, 213.75 bbl. @ 2.30	492
Extras	444
Total Cost of Bridge	$28,685

Cost per square foot horizontal area, $10.40.

The railroad paid for the following additional items—temporary structure, track raising, track diversion, raising 2 bridges, ballast, change of tracks, signals and other railway facilities—Total cost $19,841

Cost of Highway

Earth excavation, 21,622 cu. yd. @ 0.36	$ 7,806
Other grading items	1,635
Concrete pavement, 7,058.5 sq. yd. @ 1.44 (not inc. cement)	10,164
Class X concrete, 157.31 cu. yd. @ 27.50 (not inc. cement)	4,326
Cement, 3,410 bbls. @ 1.80	6,138
24-in. Reinforced concrete pipe, 493 ft. @ 5.25	2,588
Pump house	4,200
2700-gal.-per min. pumping units complete, 2 @ 1,818.00	3,636
Miscellaneous items	5,256
Total Cost of Highway	$45,749

ASHLAND AVENUE, BLUE ISLAND (STATE ROUTE 49) UNDER 5 TRACKS OF BALTIMORE & OHIO RY.

(Pavement not yet laid. Portions of highway bridge carrying Blue Island-Riverdale Road are visible in background of lower picture.)

(Photos April 30, 1935)

2 Plate girder bridges on concrete piers and abutments.

1 Plate girder span	*49 ft. 0 in.*
2 I-Beam spans, 23 ft. 9 in. each	*47 ft. 6 in.*
Total Length of 4-Track Bridge	*96 ft. 6 in.*
Width, including walk	*57 ft. 3 in.*
Horizontal Area of 4-Track Bridge	*5,525 sq. ft.*
1 Plate girder span	*50 ft. 6 in.*
2 I-Beam spans, 23 ft. 1¾ in. each	*46 ft. 3½ in.*
Total Length of 1-Track Bridge	*96 ft. 9½ in.*
Width, including walk	*12 ft. 1¾ in.*
Horizontal Area of 1-Track Bridge	*1,176 sq. ft.*
Horizontal Area, 2 Bridges.	*6,701 sq. ft.*
Clear width of roadway between piers	*44 ft. 0 in.*

Contract awarded April 18, 1934.

Cost of 2 Bridges (Semi-Final Estimate)

Class A Concrete, Class 5 (including cement), 751.53 cu. yd. @ 15.00	$11,273
Class A Concrete, Class 6 (including cement), 252.69 cu. yd. @ 12.00	3,032
Hardware, 2,279 lb. @ 0.12	273
Test piles, 2 @ 100.00	200
Precast concrete piles in place, 1,269.84 lin. ft. @ 2.10	2,667
Reinforcing steel, 17,070 lb. @ 0.035	597
Structural steel furnished (including 206 lin. ft. hand-rail 1,940 lb.), 371,888 lb. @ 0.0354	13,165
Erecting structural steel, 371,888 lb. @ 0.009	3,347
Bridge Ties—treated, 26.98 M @ 100.00	2,698
Joists, guard-rail and planking—treated, 20.07 M @ 85.00	1,706
Extra—lowering footings	1,235
Total Cost of 2 Bridges	$40,193
Cost per square foot horizontal area	$6.00

Expense incurred by railway in connection with track changes, etc., not stated.

Cast of Bridge, Subway and Fill

Class X concrete, 5,479.6 cu. yd. @ 14.85 (not including cement)	$ 81,372
Reinforcement bars, 590,479 lb. @ 0.032	18,895
C. I. rockers, 14,023 lb. @ 0.04	561
Steel bearing plates, 3,270 lb. @ 0.05	163
Name plates	80
Bituminous felt	90
Borrow excavation, 103,821 cu. yd. @ 0.55	57,102
Concrete cribbing, 135 sq. ft. @ 2.00	270
Steel expansion guard, 10,040 lb. @ 0.045	452
Standard 10" partition tile, 2,394 sq. ft. @ 0.18	431
Mesh reinforcement, 3,536 sq. ft. @ 0.037	131
Steel blast plates, 32,328 lb. @ 0.06	1,940
6-in. tile drain, 320 lin. ft. @ 0.40	128
12-in. corrugated pipe, 820 lin. ft. @ 3.25	2,665
Catchbasins, 8 @ 100.00	800
Guard Fence, 2,756 lin. ft. @ 0.65	1,791
Miscellaneous items	1,590
Cement, 9,759.5 bbl.	10,292
Extras and Miscellaneous:	
15-in. vit. pipe in place, 192 lin. ft. @ 3.775	725
Sidewalk expansion plates	185
Water-soaking embankment	4,836
Retaining wall and miscellaneous concrete	6,990
Overhaul	3,520
Finishing abutment	1,392
Miscellaneous items	97
Cement sack credits	($3,885)
Other credits	(153)
Total Cost of Bridge, Subway and Fill	$192,460
Cost of fill and other items not a part of bridge and subway structures	68,774
Cost of Bridge and Subway only	$123,686
Cost per square foot horizontal area	$6.50

HARLEM AVENUE (STATE ROUTE 42A) OVER TRACKS OF BELT RAILWAY OF CHICAGO SOUTH OF 63RD ST.

(Photo April 26, 1935)

Reinforced concrete viaduct:	
2 Spans, 46 ft. 0⅛ in. each	*92 ft. 0⅝ in.*
4 Spans, 44 ft. 11⅜ in. each	*179 ft. 9½ in.*
Total Length of Viaduct	*271 ft. 10⅛ in.*
Reinforced concrete subway (culvert type construction) having 2 16-ft openings for railway tracks	*32 ft. 0 in.*
Total Length of Structures Included in Construction Contract	*303 ft. 10⅛ in.*
Roadway width between curb faces	*62 ft. 6 in.*
2 Sidewalks, 5 ft. each	*10 ft. 0 in.*
2 Side-rails, 14 in. each	*2 ft. 4 in.*
Total width	*62 ft. 10 in.*

Constructed by Cook County—maintained by State of Illinois.

Horizontal area ..... *19,090 sq. ft.*

Contract awarded May 14, 1931.

HARLEM AVENUE OVER 4 TRACKS OF CHICAGO & ALTON RY., 1 TRACK OF SANITARY SWITCH, THE I. & M. CANAL, AND PORTAGE CREEK, NORTH OF ARCHER AVE.

(Bridge over C. & A. tracks and I. & M. Canal in upper picture; bridge over Sanitary Switch in lower; box culvert for Portage Creek not shown.)
(Photos April 26, 1935)

Constructed by Cook County—Maintained by State of Illinois.

4 *Reinforced concrete spans, each* 45 *ft.* 0 *in.*	180 *ft.* 0 *in.*
2 *Reinforced concrete spans, each* 56 *ft.* 4 *in.*	112 *ft.* 8 *in.*
1 *Reinforced concrete span*	69 *ft.* 9¼ *in.*
1 *Reinforced concrete span*	76 *ft.* 0 *in.*
Length of bridge over C. & A. Ry. and I. & M. Canal	438 *ft.* 5¼ *in.*
3 *Reinforced concrete spans, each* 22 *ft.* 6 *in., over Sanitary Switch*	67 *ft.* 6 *in.*
Reinforced concrete box culvert	20 *ft.* 0 *in.*
Total Length of Bridges and Culvert included in Construction Contract	525 *ft.* 11¼ *in.*
Roadway width, face to face of curbs	44 *ft.* 0 *in.*
2 *Sidewalks,* 5 *ft.* 0 *in. each*	10 *ft.* 0 *in.*
Total Width	54 *ft.* 0 *in.*
Horizontal area	28,400 *sq. ft.*

Constructed 1932.

Cost of Two Bridges and Culvert

Class X concrete, 6,734 *cu. yd. @* 14.75 *(not including cement)*	$ 99,328
Reinforcement bars, 769,692 *lb. @* 0.03	23,091
Cast iron rockers	1,106
Steel bearing plates, 7,357 *lb. @* 0.05	368
Name plates, 5 *@* 35.00	175
Borrow, 244,798 *cu. yd. @* 0.50	122,399
Steel expansion guard, 9,820 *lb. @* 0.08	786
Partition tile, 4,446 *sq. ft. @* 0.25	1,112
Wire mesh reinforcement, 6,541 *lb. @* 0.04	262
Blast plates, 12,240 *lb. @* 0.05	612
Broken stone and chips, 661 *cu. yd. @* 1.70	1,124
24 *in. corrugated pipe,* 185 *lin. ft. @* 4.00	740
15 *in. sewer tile,* 742 *lin. ft. @* 2.00	1,484
50 *in. storm sewer*	5,620
18 *in. cast iron pipe,* 96 *lin. ft. @* 6.00	576
42 *in. concrete pipe,* 700 *lin. ft. @* 9.00	6,300
36 *in. corrugated pipe,* 190 *lin. ft. @* 6.00	1,140
Catch basins, 6 *@* 120.00	720
Manholes, 5 *@* 100.00	500
Flagging protection—June-Sept.	751
Miscellaneous items	452
Extra lowering piers	1,685
Water soaking embankment	7,246
Relocating water main	3,318
Extra raising 1 *span*	2,963
Installing FP type guard rail	7,787
Miscellaneous extras and credits	1,929
Cement, 11,699.75 *bbl.*	11,644
Total Cost of Improvement (not including pavement)	$305,215
Deduct for fill, drainage, and other items not pertaining to bridges or culvert	157,829
Balance—Approximate Cost of Bridges and Culvert	$147,386

Cost of bridges and culvert per square foot horizontal area, $5.20.

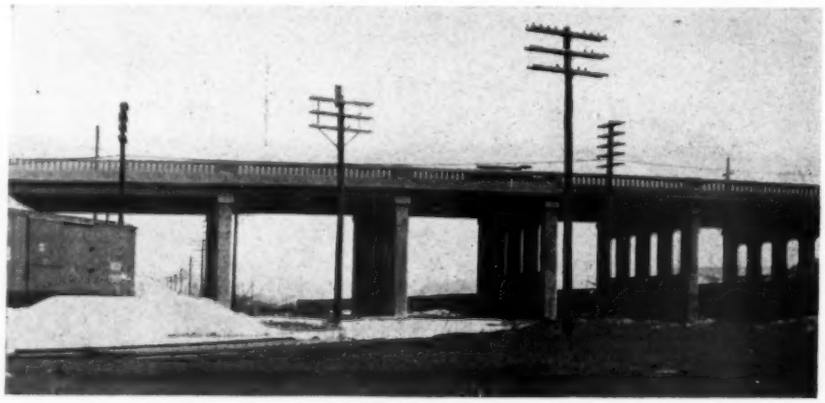
JOLIET ROAD (U. S. ROUTE 66) OVER 8 TRACKS OF B. & O. C. T. RY. AT McCOOK

(Photo April 26, 1935*)*

Reinforced Concrete viaduct.

2 *Approach spans,* 46 *ft.* 6 *in. each*	93 *ft.*
2 *Spans,* 40 *ft. each*	80 *ft.*
2 *Spans,* 36 *ft. each*	72 *ft.*
Total length	245 *ft.*
Roadway width between curb faces	44 *ft.* 0 *in.*
2 *Sidewalks,* 5 *ft. each*	10 *ft.* 0 *in.*
2 *Siderails,* 14 *in. each*	2 *ft.* 4 *in.*
Total width	56 *ft.* 4 *in.*
Horizontal Area	13,802 *sq. ft.*

Contract award Nov. 10, 1931.



Cost of Bridge

Excavation, Class C, 115.62 *cu. yd.*	$ 509
Pavement (4 *in.*) 1,204.7 *sq. yd. @* 0.66 *(not including cement)*	795
Class X Concrete, 1,987.26 *cu. yd. @* 12.90 *(not including cement)*	25,636
Reinforcement bars, 298,580 *lb. @* 0.033	9,852
Structural steel, 8,550 *lb. @* 0.06	513
Rockers and plates, 16,510 *lb. @* 0.07	1,156
Name plate	50
Tile, 2,178 *lin. ft. @* 0.20	436
Wire fabric, 2,772 *lb. @* 0.03	83
Blast plates, 5,800 *lb. @* 0.05	290
Detour	1,418
Miscellaneous extras	482
	$41,220
Miscellaneous deductions	1,200
Net Cost without State Cement	$40,020
Cement, 3,637 *bbl.*	2,927
Total Cost of Bridge	$42,947
Cost per square foot horizontal area	$3.10

Cost of Approaches

1,755 *lin. ft. including drainage and ramp entrance to private property (not including cement):*

Borrow, 80,577 *cu. yd. @* 0.332	$26,752
Pavement, 7,788 *sq. yd. @* 1.68	13,084
Other items	43,199
Total Cost of Approaches	$83,035

Expense incurred by railway in connection with track changes, etc., not stated.

OGDEN AVENUE, LA GRANGE, UNDER 2 TRACKS OF CHICAGO, WEST TOWNS TRACTION R. R.

(Steam railway bridge in background, carried on pile end and center piers.)

(Photo April 26, 1935.)

Plate girders on concrete abutments.
Girder length C to C of bearings ..... 65 *ft.* 9⅛ *in.*
Width C to C of girders ..... 30 *ft.* 6 *in.*
Horizontal area ..... 2,006 *sq. ft.*
Roadway width-clear between abutments ..... 50 *ft.* 2 *in.*
Contract awarded April 6, 1932.

Cost of Bridge

Structural steel, 102,861 *lb.* @ 0.055	$ 5,657
Class X concrete (not including cement), 462.25 *cu. yd.* @ 14.00	6,471
Reinforcement bars, 62,631 *lb.* @ 0.0325	2,034
Concrete cribbing, 82 *sq. yd.* @ 20.00	1,640
Removing solid rock for abutments	191
Boulders in footing	63
Cement, 768.25 *bbl.* @ 0.79	606
Total Cost of Bridge	$16,662
Cost per square foot horizontal area	$8.30

Cost of excavation, pavement, and railway track items not stated.

FOURTEENTH STREET, CHICAGO HEIGHTS (U. S. ROUTE 30) UNDER 3 TRACKS OF C. & E. I. RY. AND C. H. T. T. R. R.

(Photo April 30, 1935)

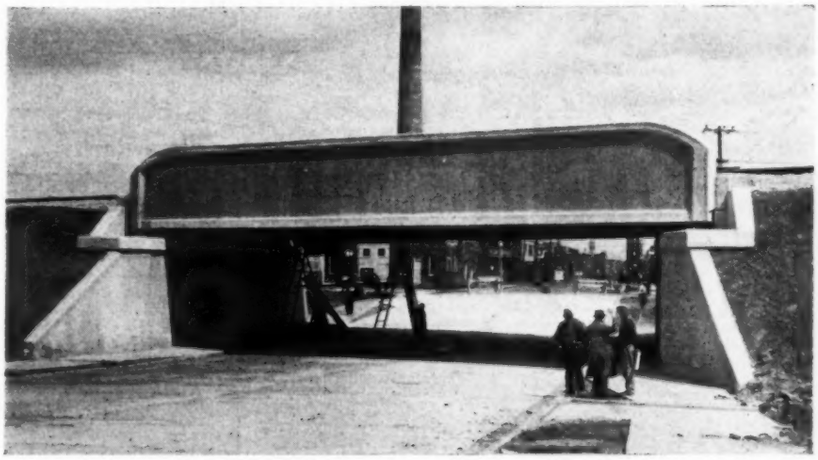


Plate girders encased in concrete.
Girder length, c. to c. of bearings 69 *ft.* 0 *in.*
Width of bridge over all ..... 54 *ft.* 10 *in.*
Horizontal area ..... 3,783 *sq. ft.*

(This bridge replaces a previous structure in the same location.)

Roadway width between curb faces ..... 42 *ft.* 0 *in.*
2 *Sidewalks,* 7 *ft.* 4 *in. each* .... 14 *ft.* 8 *in.*
Clear width between abutments. 56 *ft.* 8 *in.*
Contract awarded June 19, 1934.

Cost of Bridge (Semi-Final Estimate)

Removing old concrete, 37.52 *cu. yd.* @ 4.60	$ 173
Class X Concrete, 1,194 *cu. yd.* @ 12.35 *(not including cement)*	14,746
Reinforcement bars, 21,485 *lb.* @ 0.038	816
Structural Steel, 471,475 *lb.* @ 0.0396	18,670
Waterproofing, 4,434 *sq. ft.* @ 0.46	2,040
Corrugated perforated iron pipe, 148 *lin. ft.* @ 0.95	141
Cement, 1,850 *bbl.* @ 1.87	3,460
Borrow, 10,890 *cu. yd.* @ 0.81	8,821
Water mains extra	8,871
Other extras	663
Total Cost of Bridge	$58,401

Cost per square foot horizontal area, $15.45.
The railway companies paid for the following additional items—temporary structure, removing superstructure of old bridge, removing old steel bents, track changes, change of signals and other railway facilities.

CICERO AVENUE, CHICAGO, UNDER 4 TRACKS OF CHICAGO AND NORTH WESTERN RY., BETWEEN AINSLIE ST. AND LAWRENCE AVE.

(Photo April 20, 1935)

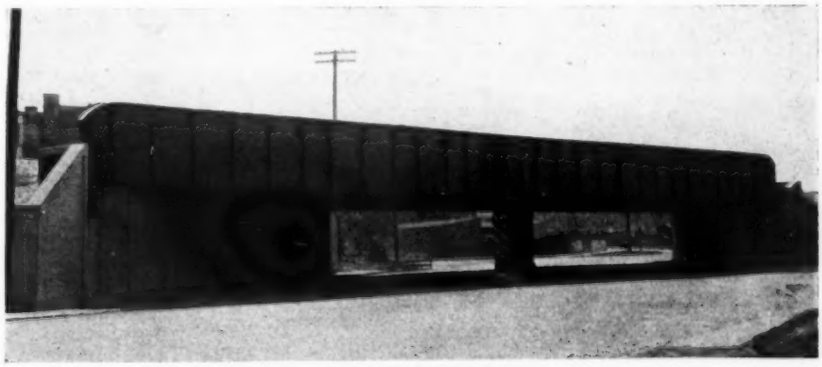


Plate girders on concrete abutments and steel center pier.

Girder length—South side .... 141 *ft.* 9¾ *in.*
Girder length—North side .... 155 *ft.* 5⅝ *in.*
Width between girders ..... 84 *ft.*
Horizontal area, about ..... 12,480 *sq. ft.*

2 *Roadways,* 28 *ft. each* ..... 56 *ft.*
2 *Sidewalks,* 7 *ft. each* ..... 14 *ft.*
Center pier footing ..... 10 *ft.*
Width between abutments ..... 80 *ft.*
Constructed 1934.

Cost of Bridge

(Abutments constructed in advancee by railway company—costs not included herewith)

Falsework	$ 1,000
Structural steel, 1,378,146 *lb.* @ 0.028	38,588
Painting	535
Concrete encasement—floor, 1,010 *cu. yd.* @ 16.00 *(including cement)*	16,160
Waterproofing, 10,556.4 *sq. ft.* @ 0.20	2,111
Ballast, 280 *cu. yd.* @ 3.00	840
Track work	400
Lighting	300
Extras	2,038
Total Cost of Superstructure	$61,972

Cost per square foot horizontal area, superstructure only, $4.95.

"THE MILLION DOLLAR MILE"

Mannheim Road (U. S. Route 45) over Tracks of C. & I. W., A. T. & S. F., and C. & A. Railroads, Des Plaines River, Chicago Sanitary and Drainage Canal and I. & M. Canal, between 79th and 96th Sts.

Length of Structures.....4,026 *ft.*
Length of Embankment.....2,485 *ft.*

Total Length.....6,511 *ft.*
Total Cost of Project.....$961,924

Upper picture taken from northern end: girder span over Des Plaines River in background.

Lower picture taken from southern end: pony truss over I. & M. Canal and through truss over Drainage Canal in background.

A fill 950 ft. long separates the parts of the project shown in the two pictures.
(Photos April 30, 1935.)

Project Officially Opened for Traffic January, 1935.

Northerly Viaduct

30 *Plate girder spans on reinforced concrete bents over existing tracks and site of proposed tracks of A. T. & S. F. and C. W. I. R.R.'s and Des Plaines River. Total length of Northerly Viaduct*.....2,723.69 *ft.*
Roadway width face to face of curbs..... 43.00 *ft.*
1 *Sidewalk*..... 7.00 *ft.*

Total width..... 50.00 *ft.*
Horizontal area.....136,184 *sq. ft.*
Cost of reinforced concrete substructure (not including cement).....$140,502
Cement in substructure..... 10,503
Cost of structural steel super-structure and 6-in. concrete pavement..... 289,645

Total Cost of Northerly Viaduct.....$440,650
Cost per square foot horizontal area, $3.25.

Southerly Viaduct

I-beams, through truss and pony truss over tracks of C. & A. R. R., Drainage Canal, and I. & M. Canal.
19 *I-beam spans*..... 975.95 *ft.*
1 *Through truss over Drainage Canal*..... 250.86 *ft.*

Total length exclusive of pony truss.....1,226.81 *ft.*
1 *Pony truss over I. & M. Canal*..... 75.50 *ft.*

Total length of Southerly Viaduct.....1,302.31 *ft.*
Width..... 50.00 *ft.*
Horizontal area exclusive of pony truss.....61,340 *sq. ft.*
Horizontal area of pony truss..... 3,775 *sq. ft.*
Cost Exclusive of Bridge over I. & M. Canal—
Reinforced concrete sub-structure (not including cement).....$138,118
Cement in sub-structure..... 10,825
Structural steel super-structure and 7-in. concrete pavement (asphalt plank pavement on truss over Drainage Canal)..... 141,396
Cement in superstructure..... 2,571

Cost of Southerly Viaduct exclusive of bridge over I. & M. Canal.....$292,910
Cost per square foot horizontal area.....$4.80

Cost of Bridge over I. & M. Canal—
Reinforced concrete substructure (not including cement).....$ 69,703
Cement in substructure..... 2,055
Structural steel superstructure and 7-in concrete pavement..... 12,923
Cement in superstructure..... 210

Cost of pony truss bridge over I. & M. Canal.....$ 84,891
Cost per square foot horizontal area.....$22.45
The high cost of this bridge was due to quicksand and boulders in foundation.

Cost of painting structural steel in both Northerly and Southerly viaducts..... $13,889

Earth Embankment

Total Length of Embankments.....2,485.00 *ft.*
Cost of Embankments.....$63,293
Cost of 40-ft. Pavement on Embankments (not including cement).....$51,380
Cement in pavement..... 14,911

Total Cost of Pavement on Embankment.....$66,291

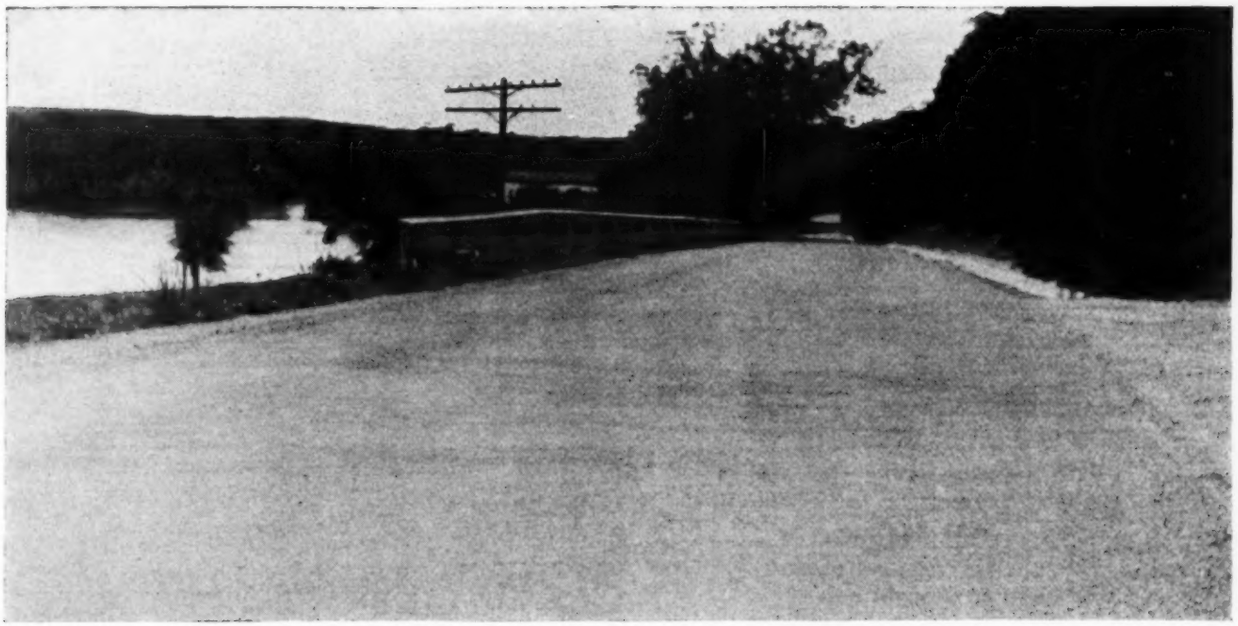
Summary of Entire Project—

	Length	*Cost*
Northerly Viaduct	2,723.69 *ft.*	$440,650
Pony Truss over I. & M. Canal	75.50 *ft.*	84,891
Southerly Viaduct exclusive of Pony Truss	1,226.81 *ft.*	292,910
Painting Structural Steel		13,889
Earth Embankment	2,485.00 *ft.*	63,293
Pavement on Embankment		66,291
Grand Total	6,511.00 *ft.*	$961,924

BURNHAM AVENUE, CALUMET CITY, OVER RAILWAY TRACKS AND CANAL

(Photo April 30, 1935)

Here is a structure of reinforced concrete, structural steel and treated timber, 2,522 ft. long, not including the side ramp shown in picture. Job completed in 1931. The timber trestle is temporary pending decision as to permanent location of canal and tracks.



Completed Drag Surface Treatment on Cannonsburg Road. Base Was Given Double Prime Treatment and Surface Treatment Was Placed Directly Thereon.

RETREADS AND SURFACE TREATMENTS IN KENT COUNTY, MICH.

By O. S. HESS

Engineer-Manager,
Kent County Road Commission

OUR experience in Kent County with bituminous surfaces covers only a period of a little more than four years. During that time a great many different methods have been tried, many of which appeared to be successful. Accordingly this paper will be an attempt to cover the experience of the past four years and particularly to present the methods of construction and procedure which in our experience have been the most successful.

Satisfactory Base Essential.—The first principle is one on which nearly everyone agree, namely, that we must have a satisfactory base if we expect any thin bituminous surface to stand up under present day traffic. Unfortunately while we all agree on this principle, very few do anything about it. In our work in Kent County, however, we have put every road through a process of rebuilding and widening a year in advance of any bituminous surfacing work. Nearly all of the old roads consisted of 24 ft. grades with varying widths and thicknesses of gravel surfaces. These grades were widened to a 36 or 40 ft. width in most cases, and the gravel surface was made 21 ft. wide and at least 6 in. thick compacted. The new gravel was compacted by the use of tamper rollers and was then maintained continuously with truck scrapers until the following season. Ordinarily the road should be sufficiently consolidated by this time to take a bituminous surface satisfactorily.

Determining Thickness of Retread.—In determining what thickness of retread should be placed, in each case we have followed the plan of simply making different observations on the road by driving over it a number of times during the spring break-up. In any particular case if no breaks occurred in the surface during this period and there were no soft spots, we would conclude that a drag surface treatment type of surface would be sufficient. If soil and drainage conditions and the appearance of the surface during the spring break-up made us skeptical of so thin a surface, we would probably decide on a 1½ in. retread. In other cases where the road showed frost boils with quite a number of breaks in the surface, we would probably decide on a 3 in. retread.

It should be borne in mind that all of these surfaces are or should be placed on moderate traffic highways. Heavy traffic roads should be surfaced with higher type pavements and roads having very light traffic probably would not warrant these bituminous surfaces from an economic standpoint.

Regardless of the thickness of the surface, our methods of construction are the same as far as the preparation of the base and the placing of the prime coats are concerned. As soon as the spring rains are over, and we reach the time when it becomes necessary to place dust layers on our roads is about the right time to start bituminous work. This is usually about May 1st. At this time, weather and temperature conditions are usually fairly satisfactory.

Prime Coat.—The first step is to place a prime coat on all of the roads included in the bituminous program. As soon as the prime coat has been placed, of course,

Placing Stone for 3-In. Retread on One Side on West Leonard Road. Retread Machine Has Just Made First Trip on Other Half of Road.

the dust nuisance is ended, and we practically have all of the advantages of paved surfaces from then on. In placing the prime coat we scrape all of the loose material to the edges of the road, leaving a practically perfect surface as to smoothness and crown. The bitumen is then applied 20 ft. wide at the rate of about 3/10 gal. per square yard. For this purpose we have used both light tars and cutback asphalts, using the same quantities of each. Both materials have given good results. After this bitumen has been allowed to soak in for perhaps a half day, the road can be opened to traffic. It is usually advisable to go over the road just before opening up to traffic and blot up any wet spots with a little additional material which can be taken from the loose gravel which was scraped to the edges. As a rule this prime coat will handle the traffic satisfactorily without damage to the surface for a period of two or three months. In any case, it is probably advisable to allow traffic to use the road at least a week or two before proceeding with the next step.

Bladed Prime Coat.—This next step might be called an auxiliary or bladed prime coat, and is not absolutely imperative. We believe it to be advisable, however, because of the additional smoothness obtained for a very small cost. The loose gravel which had previously been scraped to the edges of the road is now scraped back on to the primed surface, and spread evenly over the 20 ft. width. If there is a lack of material in occasional spots, it is advisable to add a little additional gravel on these particular spots so as to furnish a practically uniform coat of material the whole length of the road. This added material might be pea gravel, stone chips, or just ordinary maintenance gravel. As the loose material on the surface also contains considerable dirt it is necessary to use a light bitumen for this treatment. It is felt that a light tar is the best material for this particular purpose. The bituminous material which is the same as that used for the first prime coat is now applied at the rate of about 2/10 gal. per square yard. The loose material is then bladed by truck scrapers until it is all thoroughly coated and is then again spread out evenly over the surface and rolled. As soon as the surface has been rolled it can be opened to traffic. It will be found that this bladed prime coat has added considerable stability to the base and has produced a surface which is almost perfect for smoothness.

Materials Used in Prime Coat Work.—The following copies of laboratory reports are typical of the light tars and asphalt cutbacks used in the prime coat work:

LIGHT TAR

General characteristics	Fluid
Water, per cent by weight	1.5
Specific gravity at 25° C./25° C.	1.160
Specific viscosity, Engler, at 40° C	16.7
Total distillate, per cent by weight—	
1. 0° C. to 170° C.	0.9
2. 0° C. to 235° C.	10.0
3. 0° C. to 270° C.	20.0
4. 0° C. to 300° C.	27.6
Softening point of residue, ring and ball, °C.	42.8
Total bitumen, per cent	91.85

LIGHT ASPHALT CUTBACK

Grade of Base Asphalt Cement:	
Penetration at 77° F.	85-100
Loss 50 g. 5 hrs. at 325° F., %, not more than	0.3
Bitumen soluble in CS2, %, not less than	99.5
Tests on Cut Back Asphalt Cement:	
Furol viscosity at 77° F.	160-320
Equivalent specific Engler viscosity at 77° F.	40- 80
Flash °F., not less than	80
Distillation test (separation of diluent from asphalt cement base):	
% off at 275° F. (by volume)	0
% off at 437° F. (by volume), not less than	10
% off at 600° F. (by volume), not less than	30
% off at 680° F. (by volume), not more than	40
Tests on Asphalt from Distillation:	
Penetration at 77° F.	85-120
Less 50 g. 5 hrs. at 325° F., %, not more than	1
Ductility of residue, cm., not less than	100

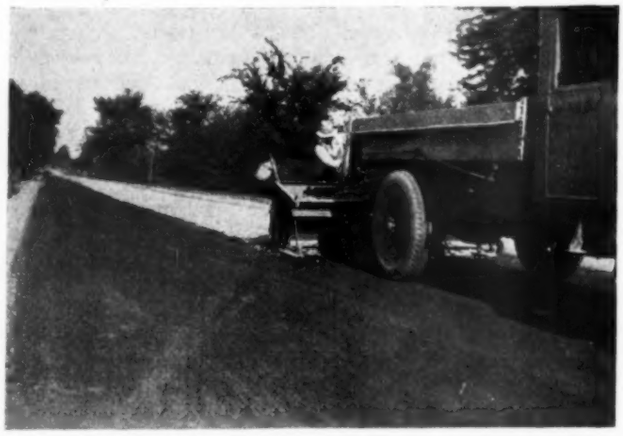
After the double prime coat has been completed as described the road is capable of satisfactorily handling traffic the entire balance of the season, and in many cases would even go over into the next season with no serious breaks in the surface. It is always advisable, however, to either surface-treat this road during the same season or else place retreads of thicknesses which are suited to the particular roads in question. It is found that many of the roads can be completed satisfactorily by just simply placing a proper drag surface treatment without any other material between the double prime and the surface treatment. Whether or not a retread is placed the surface treatment work is the same and will be described later in connection with the surface treatment on retreads.

Retread Mix.—In general our retreads have been either 1½ in. or 3 in. in thickness. We have tried other thicknesses but these seem to be the most practical for the material which we are able to obtain in Grand Rapids.

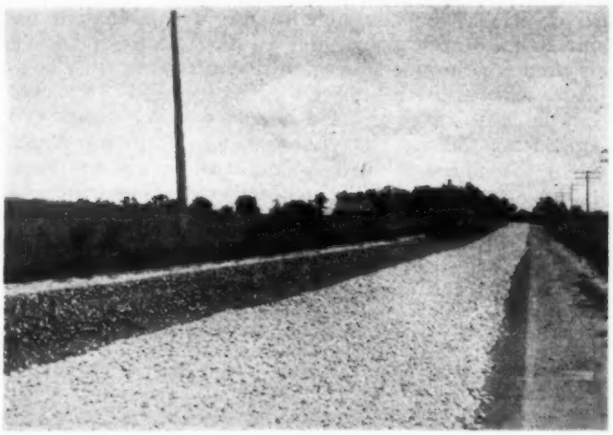
The following two sets of specifications are the specifications for the two types of crushed stone which were used respectively in the 1½ in. and 3 in. retreads:

SPECIFICATIONS FOR ¾ IN. CRUSHED STONE FOR RETREAD

Crushed stone shall consist of hard, durable particles of rock free from soft or disintegrated stone, and from dirt or other



Applying Crushed Stone on Primed Surface for 3-in. Retread on West Leonard Road.



Mixing 3-In. Retread on One-Half of West Leonard Road Where Bituminous Material Has Been Applied. Placing of Stone and Application of Bituminous Material in Progress on Other Half of Road.

objectionable matter occurring either free or as a coating on the stone. When tested by means of laboratory screens and sieves the product shall meet the following requirements:

	Per cent
Passing ¾-in. round screen	100
Passing ½-in. round screen	50- 75
Passing ¼-in. round screen	5- 25
Passing 8-mesh sieve	0-1.0
Clay and silt	0-1.0
Uncrushed stone	0- 5
Thin or elongated pieces	0- 5
Washing	Required

SPECIFICATIONS FOR 2-IN. CRUSHED STONE FOR RETREAD

Crushed stone shall consist of hard, durable particles of rock free from soft or disintegrated stone, and from dirt or other objectionable matter occurring either free or as a coating on the stone. When tested by means of laboratory screens and sieves the product shall meet the following requirements:

	Per cent
Passing 2 -in. round screen	100
Passing 1½-in. round screen	90-100
Passing 1¼-in. round screen	70- 85
Passing ¾-in. round screen	15- 35
Passing ½-in. round screen	0- 15
Passing 8-mesh sieve	0-1.0
Clay and silt	0-1.0
Uncrushed stone	0- 10
Thin or elongated pieces	0- 5
Washing	Required

The crushed stone was obtained from the commercial gravel plants in Grand Rapids and was crushed oversize gravel conforming with the above specifications.

Placing Stone on Road.—In placing the stone on the road a stone spreader was used in order to obtain a surface with uniform thickness. It should be borne in mind that when a retread is mixed with the multiple blade type retread paver the surface necessarily widens somewhat with each round trip of the machine. It is, therefore, advisable to place stone on the round about 18 ft. wide if the finished surface is to be 20 ft. in width. We have ordinarily placed a sufficient quantity of stone 18 ft. wide to be the equivalent of a surface 20 ft. wide and 1½ in. thick loose measure. The bituminous material may then be placed 18 ft. wide and the mixing process started. On retreads as thick as 3 in. it is advisable to handle each half of the road separately so that the application of bitumen and the mixing process may be carried on at the same time that stone is being hauled and placed on the other half of the road. This plan will effect a little greater efficiency on the work and will avoid taking the chance of having long stretches of road rained on during the construction process.

The bituminous material is applied at the rate of 6/10 gal. per square yard for 3 in. retreads or 4/10 gal. per square yard for 1½ in. retreads, and the retread machine follows with the mixing process as closely as practicable. A medium tar or cutback asphalt is used at this time.

Laboratory Reports.—The following copies of laboratory reports are typical of the medium tar and cutback asphalt used for this purpose:

MEDIUM TAR

General characteristics	Fluid
Water, per cent by weight	None
Specific gravity at 25° C./25° C.	1.183
Specific viscosity, Engler, at 40° C.	57.1
Total distillate, per cent by weight:	
1. 0° C. to 170° C.	0.7
2. 0° C. to 235° C.	8.8
3. 0° C. to 270° C.	16.8
4. 0° C. to 300° C.	25.3
Softening point of residue, ring and ball, °C.	48.4
Total bitumen, per cent	91.59

CUT BACK ASPHALT

Specific gravity at 60° F.	0.958
Flash, °F.	115
Specific viscosity at 122° F.	80
Distillation Test:	
% off at 437° F.	14
% off at 600° F.	26
% off at 680° F.	29
Test on Distillation Residue:	
Penetration at 77° F.	82
Ductility at 77° F.	100+
Soluble in CS2	99.8

In general the bituminous material used in the mix should be about as heavy as can be handled properly in summer weather. Care should be taken, however, not to use a bitumen which is a little too heavy or else a great deal of difficulty will be experienced during the mixing and laying out process.

Mixing With Retread Machine.—In doing the mixing with the retread machine it has been found advantageous to make the first round trip with the tail gate up. This does just as good a job of mixing and requires much less power. On the second round trip the tail gate should be placed so as to partially level off the material, but no attempt should be made to leave a perfect surface until the third or last round of the machine. On this case the tail gate should be set so as to leave the stone spread out uniformly to the proper thickness and crown and care should be taken on this last round to bring the material exactly to the 20 ft. point or proper edge line. With sufficient experience it will be found the crew will be able to do this very nicely, and that no handwork whatever will be needed in order to leave the stone laid out to the proper thickness, crown, and width and with nice straight lines on the edges.

The retread mixture is next given one longitudinal rolling. We have been using a 10-ton tandem roller for

Rolling 3-In. Retread on West Leonard Road, Which Has Been Mixed and Spread with Retread Machine.

Bladed Prime Surface After Completion on Covell Road. Drag Surface Treatment Will Be Placed Later.

this purpose. After the surface has been rolled once, a heavy bituminous material is applied at the rate of 3/10 gal. per square yard for 3 in. retread or 2/10 gal. per square yard for 1½ in. retread. The following specifications are typical of the tar used for this purpose:

HEAVY TAR

Application temperature (approximately)	200 to 250° F.
Specific gravity at 25°/25° C.	1.20 to 1.26
Water, % by volume, not more than	0
Float test at 50° C., seconds	160 to 220
Distillation, 100 grams:	
% by wt. to 170° C., not more than	1
% by wt. to 300° C., not more than	20
Distillation residue softening point—degrees C. (R. and B.), not more than	65
Total distillate to 300° C., sp. gravity 30°/38° C., not less than	1.02
Total bitumen (sol. in CS2), % by wt.	80-95

This tar was applied at a temperature of about 250°

The cutback asphalt used at this stage of the work was the same as that used in the mix. Our experience has indicated that it is advisable to place a heavy bituminous material on the top of the mixed aggregate surface instead of using the same total quantity in the mix, using only a medium material. By cutting down the quantity of medium tar in the mix and placing a heavy material on the surface we add toughness to the upper part of the retread where it is needed. This application of heavy material is followed by 5 to 10 lb. of pea gravel and the whole surface again rolled.

It is worth mentioning that if the pea gravel is applied early in the morning when the bitumen is still cool, the trucks spreading the pea gravel may travel forward over the surface without sticking. After the rolling has been completed the road can usually again be opened to traffic. If the weather is quite hot, it is sometimes advisable to keep the road closed an additional day at this stage of the work. Traffic should use the road at least a week or two before going on with the surface treatment.

Drag Surface Treatment.—Of course the most simple method of completing the job is to place an ordinary hot seal by applying a heavy bituminous material on the road of about 3/10 gal. per square yard, and covering with about 25 lb. of pea gravel or chips followed by rolling. This would effectively seal up the surface, but would not materially add to the smoothness. As present day traffic is becoming increasingly more critical of the riding qualities of our highways, we believe it advisable to finish these retreads with drag surface treatments in order to obtain more smoothness.

In this case the pea gravel is placed on the retread surface ahead of the bituminous material. The pea gravel is applied at a rate of about 25 lb. per square yard or it may be advisable to use a combination of about 20 lb. of pea gravel and 5 lb. of clean sand such as is used for the fine aggregate in concrete work. This mixture will furnish a little tighter surface and one which is less liable to ravel or scale in cold weather.

In placing the pea gravel it is advisable to use some kind of machine or chip distributor which will insure a uniform distribution of the material over the surface.

The following specifications covering pea gravel are used in our work:

SPECIFICATIONS FOR ⅜-IN. PEA GRAVEL

This material shall consist of clean, hard, tough, durable particles, free from soft or disintegrated particles, dirt or other objectionable matter, and when tested by means of laboratory screens and sieves shall meet the following requirements:

	Per cent
Passing ½-in. round screen	100
Passing ⅜-in. round screen	95-100
Passing ¼-in. round screen	50- 80
Passing 8-mesh sieve	0- 5
Clay and silt	0- 1
Washing	Required

Next the bituminous material is applied at the rate of 3/10 gal. per square yard, using the same grade of tar which was used in the retread mix and the grade of cutback asphalt which was used in the prime coat work. The bituminous coated pea gravel is then thoroughly bladed back and forth by truck scrapers until the stone base has been thoroughly smeared over with the bituminous material and the pea gravel has been thoroughly coated. Then it is spread out uniformly over the surface by the scrapers.

In doing the blading it is suggested that the material on one-half of the road be kept on that same side of the road all of the time—in other words, do not scrape the material from one side of the road to the other, but simply turn it back and forth, keeping each half by itself. This simply prevents thick and thin spots in the final surface treatment when it is laid out.

After the mixed material has been laid out properly washed sand should be applied uniformly over the surface at the rate of about 5 lb. per square yard. Then the whole surface should be thoroughly rolled again. This will complete the construction of the retread and it may be opened to traffic practically as soon as the rolling has been completed.

It might be mentioned that in much of our work during the past season, about 5 lb. of pea gravel was used on the surface just previous to rolling instead of 5 lb. of sand as above mentioned. We later found that in some cases this resulted in a surface which was quite porous and had a tendency to ravel when cold winter weather started. This tendency to ravel, however, was checked by applying 15/100 gal. per square yard of heavy bituminous material on the surface about November 1st, followed by 2 or 3 lb. of sand. While this effectually checked the tendency to ravel, it was an additional expense which was avoided in some of our work by using sand in the manner above described.

There are many instances where plain surface treatment without dragging are necessary or advisable. This will occur on maintenance work and may be used satisfactorily in the surface treatment of gravel surfaces instead of the drag surface treatment type as described in this article. We have also used plain surface treatments on old worn-out concrete surfaces. If the right materials and methods are employed nearly any kind of paved surface may be sealed up by this method. For this purpose a heavy tar conforming to the following specifications has proven very satisfactory:

HEAVY SURFACE TREATMENT TAR

General characteristics	Fluid
Water, per cent by weight	None
Specific gravity at 25°C./25° C.	1,198

Float test at 32° C., seconds	111
Total distillate, per cent by weight:	
1. 0° C. to 170° C.	0.0
2. 0° C. to 235° C.	2.3
3. 0° C. to 270° C.	10.3
4. 0° C. to 300° C.	17.8
Softening point of residue, ring and ball, °C.	44.3
Total bitumen, per cent	92.10

This material is applied at a temperature of from 200° to 250° and is then followed by an application of pea gravel or chips which should be rolled in. Our practice on this type of treatment has followed the plan of using 3/10 gal. of tar per square yard followed by 25 lb. of pea gravel. The result is a very tough and durable surface which will stick to almost any kind of solid base, and will hold for a long time without further treatments.

No attempt has been made in this paper to compare various types of black top surfaces, but rather to limit our remarks to the work which has been carried out in Kent County. During the past 4 years we have built 40 miles of black top surfaces consisting of ½ mile of oil gravel, 1 mile of 3 in. cutback asphalt retread, and the balance tar retreads and surface treatments of varying thicknesses. It is evident from these figures that our experience has been limited largely to the use of tar as a bituminous material, the other types having been used in a limited way only.

Costs of Retreads.—As to the costs of the various types of retreads described in this paper, the drag surface treatment types which really amount to a mat from ¾ in. to 1 in. in thickness have cost 11 ct. per square yard or from $1300 to $1400 per mile of 20-ft. road. The 1½-in. retread surfaces showed an average cost of 26 ct. per square yard, or about $3100 per mile of 20-ft. road. The 3-in. retreads cost 40 ct. per square yard or approximately $4800 per mile of 20-ft. surface.

In conclusion, it is well to again emphasize the importance of the base in constructing any type of black top surface. Without a uniform, well-drained, and stable base, failures are sure to occur. A common danger lies in the tendency to place a black top surface on new bases which have not been given sufficient time to compact. There are very few instances where the tops should be placed in less than a year after the construction of the base. Even so, it is imperative that the gravel surface be assisted in the compaction through the use of tamper rollers and calcium chloride. The rolling should immediately follow the placing of the gravel, and should continue until the surface does not cut up or rut under traffic. A calcium chloride dust layer should be used during the summer months, and it will not only assist in compacting the gravel, but will help to hold the correct shape of the road. If calcium chloride is not used, it must be expected that a long time must elapse before the top can be placed.

The conclusion should not be drawn that these black top surfaces are going to be satisfactory and economical under all conditions. As previously stated, they are particularly applicable to the class of roads which fall in the moderate traffic group. Soil conditions also play a very important part in the success or failure of these surfaces. If good judgment is exercised, however, in the selection of the roads, the preparation of the bases, etc., there is no reason why these low cost bituminous surfaces should not furnish all of the advantages of higher type pavements on the particular roads where they are used.

The foregoing is a paper presented at the 1935 conference on highway engineering at the University of Michigan.

Motor Transport for New Countries

PRIOR to comparatively recent developments in heavy motor vehicles, the only way of opening up new countries in the British Dominions and Colonies and thus securing additional freight for existing railways was to build branch lines. These were costly to construct and could not possibly pay their way, in any but a mining area, until a very considerable volume of traffic had been gradually built up. For some years the Government Oversea Mechanical Transport Directing Committee, of which J. C. May, London, England, is secretary, has been endeavoring to solve this problem by the use of motor transport.

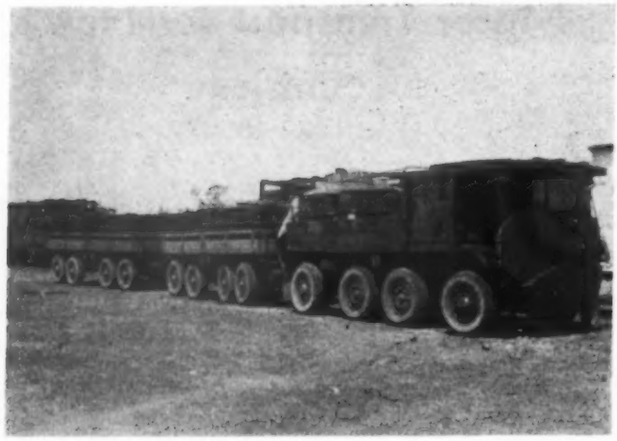
The First Motor Unit.—Their first motor unit underwent a test in 1933 in the Gold Coast covering 8,000 miles of driving on lightly constructed roads under commercial working conditions. Part of the trials took place in the height of the rainy season. This test was highly successful and at the end of the trials the Gold Coast Government bought the unit for their own use. This first unit consisted of an 8-wheeled tractor, driven on all wheels and carrying a load of 3 tons, and two 8-wheeled trailers each carrying a load of 6 tons. By thus spreading the load over 24 wheels fitted with large low-pressure pneumatic tires, the pressure imposed on the ground by the unit when carrying a useful load of 15 tons was less per square inch than that of a 30-cwt. truck, the lightest form of commercial vehicle in general use oversea. Further, all the axles were capable of independent vertical movement in order to reduce shocks to the vehicle and to the road.

The Second Unit.—This unit, in 1934, completed a test of 9,937 miles in the heart of Australia with signal success. The second unit is powered by a Diesel engine. Owing to the success of the experimental features of the first unit, radical changes in design were unnecessary, but it was found possible in the second to apply the lessons learned in the trials of the first, and thereby not only to simplify design but also to reduce construction and maintenance costs by utilizing as many A.E.C. standard parts as possible. For example, whereas all the wheels of the first tractor were steered, in the second only the first and fourth pairs of wheels were steered.

The weight which the second unit can carry is still nominally only 15 tons, but in practice on good surfaces and without steep gradients the trailers can each be loaded with 8 tons, which with 4 tons carried on the tractor gives a total paying load of 20 tons.

The Australia Tests.—Like the test of the first unit in the Gold Coast, this one was conducted under commercial running conditions, ordinary commercial freight being sought and paid for. The complete tests under commercial running conditions occupied 29 weeks, during which 9,937 miles were covering. The ton-mileage amounted to 81,933 and the average load carried was 8.72 tons. The test period can be analyzed as follows:

	Days
Running	130
Loading and unloading	31
Delay in securing spares	19
Rest	11
Maintenance	9
Delay due to weather	3
Total	203



Unit Loaded with 3,000 Gal. of Gasoline

The vast majority of the 9,937 miles traversed could only be called earth roads by courtesy. These bush tracks were seldom either graded or drained and usually consisted only of two ruts made by previous vehicles. As the gauge of these ruts did not fit that of the unit, their presence only made the task of the latter more difficult.

The surfaces varied from deep sand and plains covered with loose stone, to heavy sandy creek crossings, black soil, and deep mud after rains, and the temperature was at times tropical. Nevertheless, the unit continued at work hauling its paying load of 15 tons at times when only the lightest motor vehicles of the ordinary type could keep the road. During the whole time, despite the severity of the test, there were only two mechanical breakdowns, both occurring to standard parts and neither of serious importance.

The fuel consumption averaged 3.15 miles per gallon of Diesel oil, and the speed 12.87 miles per hour over the entire distance covered by the tests. These figures were most satisfactory considering the 81,933 ton-miles involved and the cross-country conditions of operation. It was found possible to cover distances up to 170 miles in a day at an average speed of 17.45 miles per hour when lightly loaded on return journeys. On some of such journeys the fuel consumption averaged 4.5 miles per gallon.

The cost per net ton-mile at which the unit worked during the 29 weeks' tests was 7.4 ct. It is important to note that this is an actual working figure and not an estimated one. Depreciation is based upon a life of 100,000 miles, and interest has been calculated at 4 per cent. While on all outward journeys the unit was loaded to its normal capacity of 15 tons and sometimes carried up to 20 tons, little return freight could be obtained, with the result that the average load was only 8.72 tons. This naturally reacted on the cost per ton-mile, which would have been considerably lower with better average loading. Another factor which increased the cost per ton-mile was the large amount of time which had to be spent on loading and off-loading owing to the lack of facilities and appliances. The proportion of working time spent in loading, off-loading and waiting for spare parts amounted to as much as 30 per cent of the total period occupied by the tests.

Motor Unit in Australian Test Crossing a Creek

30-Ton Unit Proposed.—The Oversea Mechanical Transport Directing Committee feel that, while these results are gratifying, only the first stage of their task has been accomplished. When they started work they chose a load of 15 tons as being well within the possibilities of tires and engines in their state of development at that time, but from the beginning they recognized that it should be possible to design a unit of greater capacity, and from their experience they are confident that an axle load of 4½ tons can be employed on the average earth roads of the Dominions and Colonies.

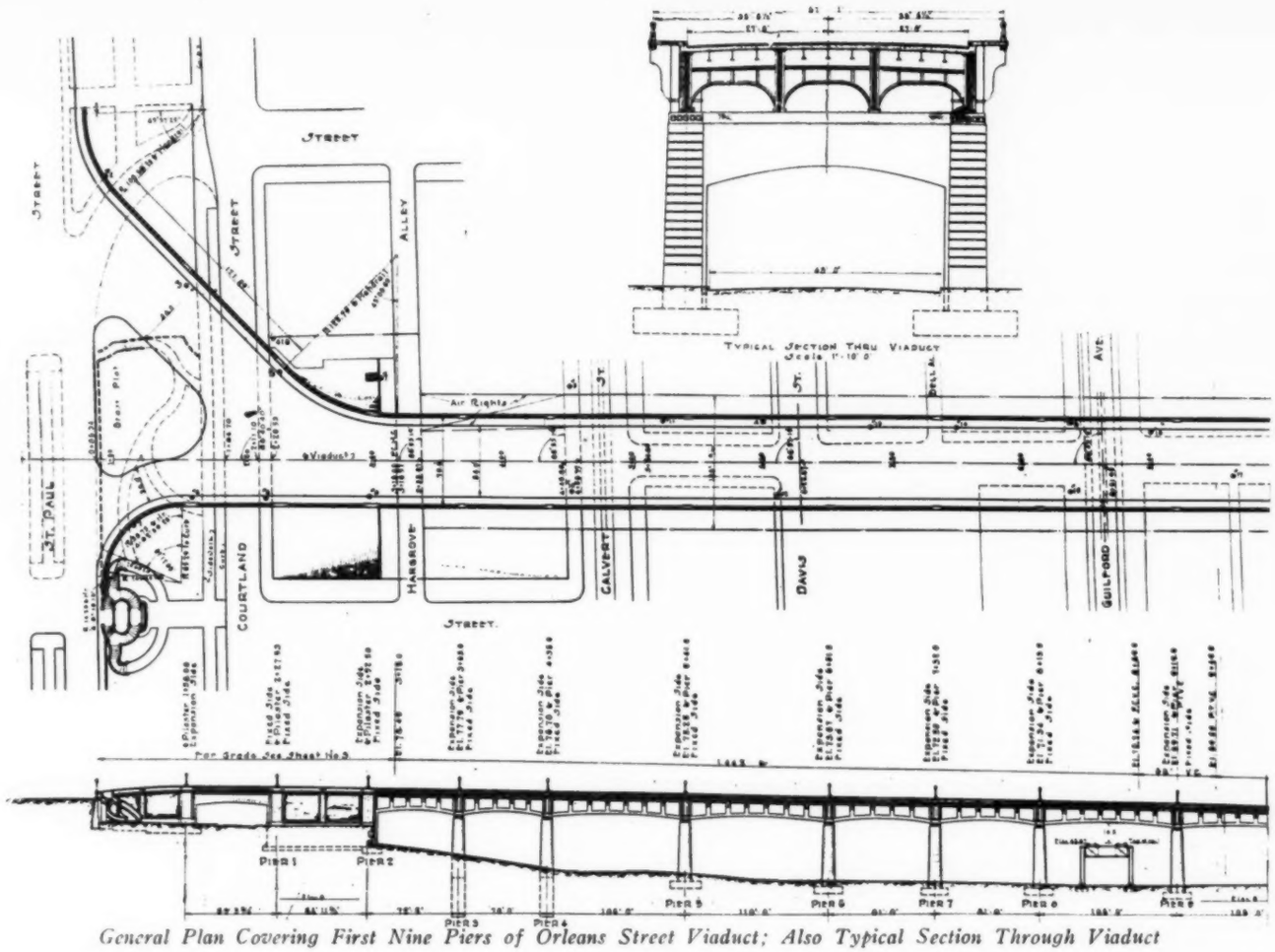
They have accordingly prepared the preliminary design of a 30-ton unit, consisting of a tractor carrying a load of six tons, and two trailers each carrying 12 tons. In their opinion, with a paying load of 30 tons the ton-mile cost would be reduced substantially below 7.4 ct. without material increase in road maintenance costs above those imposed by the ordinary 3-ton truck at present, and such a cheap instrument of transport would permit the development of areas at a considerable distance from rail and assist the railways themselves by enlarging the zone they tap without the need of incurring the initial expense and risk of a branch line.

▼

Book Review

Outline of Town and City Planning, by Thomas Adams, foreword by Franklin D. Roosevelt. Size, 6x9; 368 pages, 126 illustrations; published by Russell Sage Foundation, 130 East 22nd St., New York, N. Y.; $3.00 net.

A general understanding of the purposes, the past history, and the present possibilities of city planning is an important social need of today. To meet that need—not alone for city planners, architects, and special students, but for the general reader as well—this book has been prepared. It presents simply, briefly, and in historical sequence the story of the planning of cities. It begins with ancient cities where defense was a chief consideration—Ninevah, Babylon, Jerusalem, the cities of the Nile, the Chinese, Greek, Roman, Mayan cities. The narrative proceeds through the close-walled feudal cities, the artistic glories of the cities of the Renaissance. It continues with a much fuller treatment of the modern period, when the automobile and the massing of great populations have brought new and urgent problems, expanding the scope of planning to regions, states, and whole nations. It describes the evolution of the planning of Washington as perhaps the greatest example of effective city planning. It closes with the criticism that "too much planning has ended on paper," and with a call for action and positive achievement. Consideration is given to the aims and methods of city planning and its probable future, but technical discussion has been avoided. There are bibliographical notes and a comprehensive index.



General Plan Covering First Nine Piers of Orleans Street Viaduct; Also Typical Section Through Viaduct

THE ORLEANS STREET VIADUCT, BALTIMORE

A Solution of Problem of Handling Through Traffic

By J. L. HARRISON
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AS one views the Orleans Street Viaduct—sometimes also called the Bath Street Viaduct—now nearing completion in Baltimore, Maryland, he is tempted, in the slang of the day, to inquire, What's the big idea? What's it all about? Certainly it's quite a structure. It's evident it's to carry vehicles. But what's it doing down there in lower Baltimore with no rivers to cross and not much by way of railroad yards to span? Aren't the streets big enough?

Well, that's about it. They aren't! So the city is building the viaduct? Oh, no, the State Roads Commission is building it. Really, it's a project for which the state has provided some funds, borrowed through the Federal Emergency Administration of Public Works—customarily known as the Public Works Administration—the balance having been contributed by the Federal Government, part of it through the Public Works Administration and part of it through the Bureau of Public Roads. General supervision over the work is under the Bureau of Public Roads. Detailed supervision is in the hands of the Maryland State Roads Commission.

The responsibility for this structure has been noted in some detail because, though structurally neither bizarre nor particularly unusual, a great deal of interest nevertheless attaches to it because it will stand as the concrete expression of a definite effort to meet a problem of growing complexity—the problem of handling through highway traffic in large cities.

The Through Highway Traffic Problem—In its more general form, this problem is not difficult to state. From the earliest historical times, cities have had streets, not always good streets, not always straight or wide, but

always there have been streets. In general these streets have served to permit people to get about in these cities. Moreover, as a matter of observation, it may be remarked that usually there has been rather a definite relation between the amount of getting around there is to do and the manner in which it is done and the width of the streets. In China, where most of the vehicles until recently were small, many of the streets in the old cities are less than 10 ft. wide. No use for wider streets! Only pedestrians and rickshaws used them. True, there always are a few wider streets, streets used by heavier vehicles or to carry traffic in larger volume, more particularly in the business sections of these cities. Still, the fact remains that the streets were, for the most part, designed to permit people who lived there to get about within their city.

The streets in modern cities, particularly those in this country, are wider than the streets of ancient cities and wider than the streets of most European cities largely because we do more getting around, because we use larger vehicles to get around in, and because "getting around" today involves moving commodities in far greater volume than ever has been even dreamed of in the past. Still, the fact remains that the city street was set aside and improved to enable those resident in the city to get about in it, and, in general, for no other purpose. That "and in general for no other purpose" is important. It deserves a lot of emphasis. City streets were never laid out or improved as general public utilities! Cities have not refused outsiders access to them. Their streets are there, free to those who wish to use them. Still, they are part and parcel of the city, city facilities, sufficient, supposedly, to serve the needs of the city.

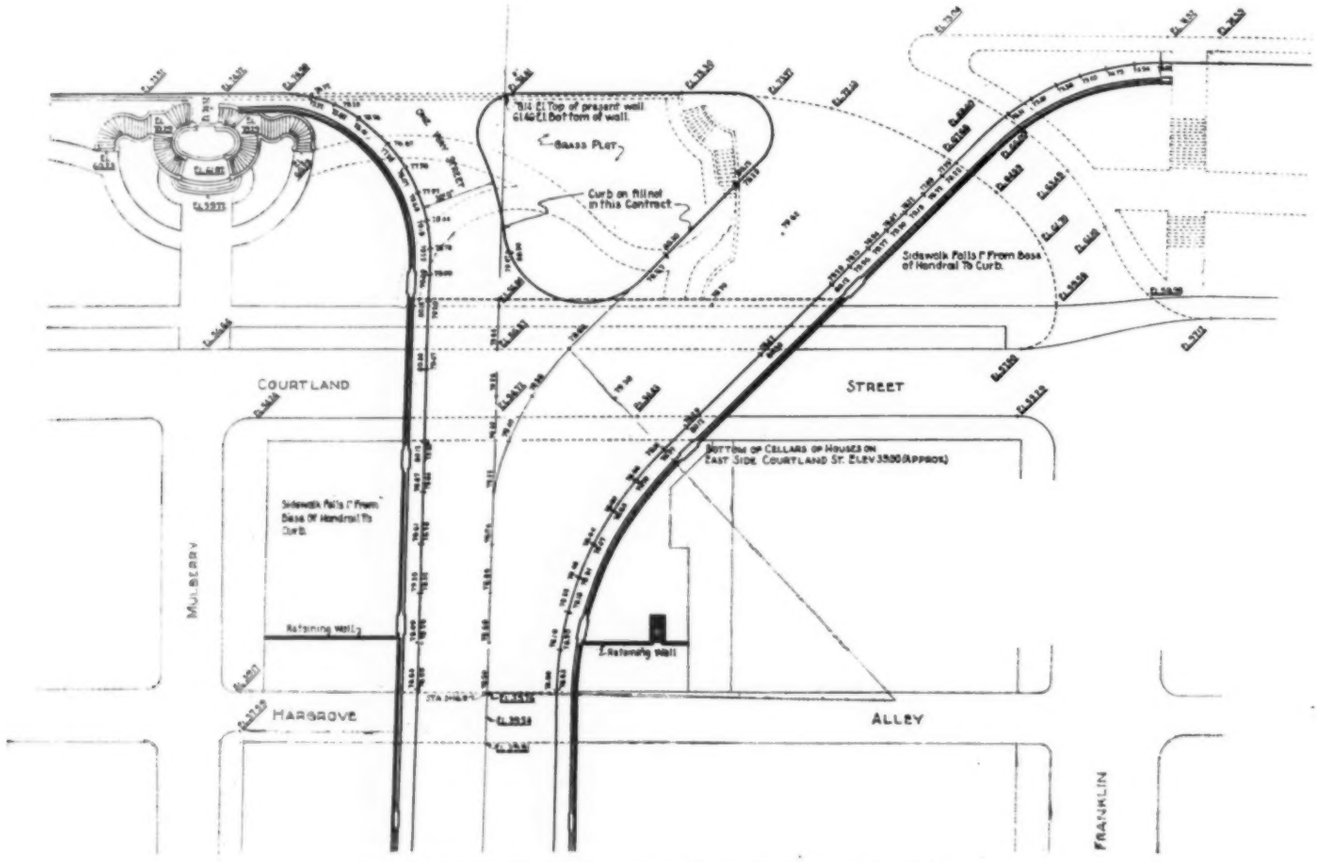
The Street Situation in Baltimore—They—but why go on? Let's let it go at that—the city streets are city facilities designed to serve the city needs. And then let's take a look at Baltimore, or any other Eastern city. Any number of streets laid out more than 200 years ago. Really, what is now Baltimore started as three separate towns. Streets were laid out as town streets and with no idea that at some future time they would all be streets in one large city. So it is not surprising that they were laid out on different plans and that these plans do not show a common angular variation either from true north and south or from true east and west.

The situation is further complicated by the fact that the Baltimore area involves some low lands along the bay and a sharp rise to the hill land on which most of the city now stands. Steep grades in a city always are objectionable even if unavoidable. They encourage traffic to move too largely on the more favorably located streets. Other streets carry less than their fair share of traffic.

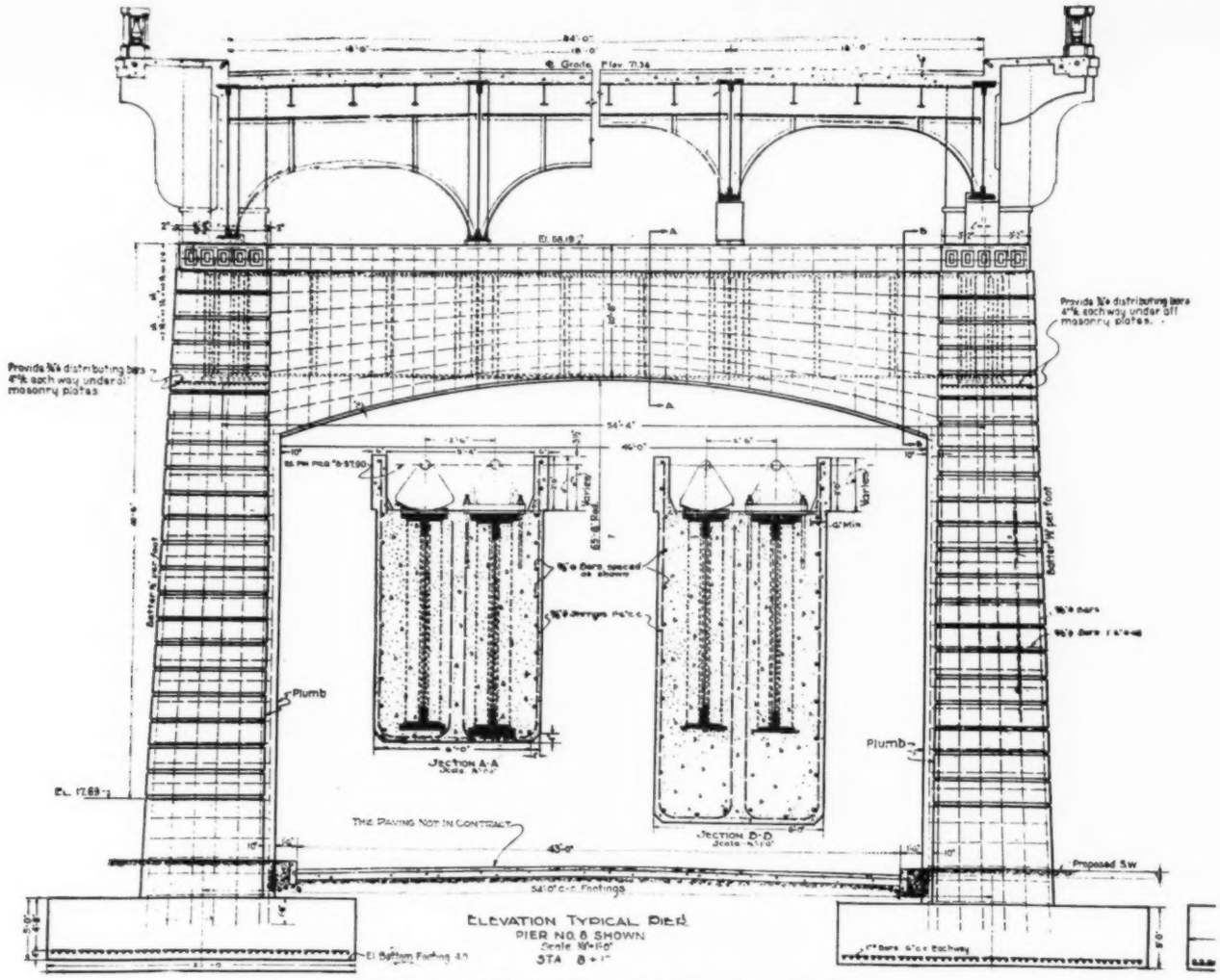
And these Baltimore streets—are they adequate for city needs? When laid out as village streets, no doubt, they were adequate for village needs. Are they adequate today?

What a question! Since they were laid out we have accumulated over 25,000,000 motor vehicles, and Baltimore, like other large cities, has its fair share. But people don't buy cars as ornaments! They buy them to use. It's reasonably certain that the average owner drives his car not far from 8,000 miles a year. If he lives in a city, he will average, recent studies suggest, some 10,000 miles a year.

And now we begin to reach the rub of this matter. Does he drive that 10,000 miles on the city streets so carefully provided for his use? Well, we don't know as much about that as we should, it's being studied



Plan of West Approach, Showing Curb and Roadway Elevations



Elevation of Typical Pier of Orleans Street Viaduct

rather intensively right now, but such information as has so far been gathered indicates rather strongly that only about half of that 10,000 miles a year is driven on the city streets. The other half? Most of that goes onto the state highway system. A little, quite a little in gross volume, goes onto roads of lesser importance. The owner "ranges around," "goes places," either on business or for pleasure.

And now we're getting pretty close to that Orleans Street Viaduct, and to the problem the highway department in almost every state as well as the Federal Government is facing today. The cities have good streets, but those 5,000 miles or so the motor vehicle owners who live in the cities want to drive on these streets every year have loaded them about to capacity, some of them far beyond any reasonable capacity, the comfort and the safety of the users being considered, to say nothing of their time.

But, after all, this is a city problem. We have admitted that the city streets are city facilities. If more facilities are needed to take care of the desire of the residents to get around in their own city, well, that's always been a city problem, and here "always" runs back as far as history runs back. We offer no objection to treating it as a city problem today.

Tying City Streets and Country Roads—On the other hand, the other 5,000 miles, the half of his annual drive the city dweller takes on the state highway system and on the rural highways, is by no means a city problem. He has paid his share of the cost of building the state highway system, paid it in license fees and in the gas tax, so his right to use this system is quite equal to his right to use his own city streets. But, to get onto it. There's the rub. His streets system is good. His state highway system is all right. But how to tie the two together, that's a problem. It's the devil's own time to get from his street system onto the state highway system on a lovely Sunday afternoon when everyone else in the city has the same idea of honoring the Sabbath day! Even on a busy week day it's none too easy. Often it takes longer to drive five miles to reach the highway system than it takes to drive 50 miles on the open road. A part owner in both systems and a user of both, the city man finds that each is splendidly designed and splendidly built, but that their "tie in" still needs attention.

And when he reaches the next large city as he "ranges around" he finds he is a unit in a large stream of traffic which must cross that city to proceed on its journey. Certainly it's not the business of the city to care for this traffic. True, a part of it—in the case of Baltimore a large part of it, for Baltimore trafficwise is a terminal city—should be taken care of on the city streets, for it is city business. But a large part of it is business which

has no interest in the city and in which the city has no interest—traffic to which the streets through the city are merely mileage on a well recognized route of travel. As long as there was plenty of room on the city streets, no one thought of questioning the right of through traffic to use these streets, took the right to do so as a matter of course. But as use the city residents were making of their streets increased, questions began to be raised as to whether, after all, it was the city's business to take care of this "through traffic." Wasn't it a fact that this through traffic had no real right of any kind to ask the use of the city streets when it had no interest in the city and no business to transact there?

The Static Responsibility for Through Traffic—Naturally, there has been a great deal of discussion of rights, properties, necessities, etc. The city viewpoint has never been exactly the same as that of the state highway departments. Different interests to serve and different problems to solve have made it difficult to reach a common point of view. Still, as city streets have become more and more congested and as "through" traffic has been more and more delayed by this congestion, the common need of a solution has tended to develop a common point of view—that providing facilities for through traffic is a responsibility of the states and of the Federal Government rather than of the cities through which this traffic passes. Just how this now widely accepted point of view will find a practical expression remains to be determined. By pass routes? Yes, obviously. City streets widened at state expense where used by through traffic? Certainly. In fact, a good deal of this already is being done. But this is not likely to prove to be the final solution of the problem. It isn't very difficult to ascertain the amount by which a street must be widened to pick up a given volume of through traffic without interfering with the traffic already using it. But a solution of this sort merely provides "room" for the through traffic at state and federal expense rather than at city expense. It does not avoid the slow travel speeds which the frequent crossings of other streets make unavoidable in congested urban areas. No, wider streets is not the last word in the solution of the problem of getting through traffic through our larger cities. And this is one reason—perhaps the major reason —that special interest attaches to the Orleans Street Viaduct. It is a somewhat different solution of the problem of getting through traffic across the city.

How Baltimore Is Meeting Through Traffic Problems—Bear in mind that Baltimore is one the greatest arterial highways in this country, probably the greatest in the world, the artery that connects Boston, New York, Philadelphia, Washington and Richmond. Over most of this route there is a four-lane highway. In many places closely parallel routes in reality provide a good many more than four traffic lanes. The traffic movement is enormous. As a sample, the average daily through traffic on the four-lane highway between Baltimore and Washington is nearly 8,000 vehicles. Local traffic brings the average daily traffic at points near Baltimore and near Washington to more than twice this figure. Much of this is truck traffic. The traffic north of Baltimore is just as heavy but is now split between two or three routes, though shortly it is likely to be more concentrated, for the state with Federal assistance is now constructing a new four-lane high-speed highway on the route toward Philadelphia, which should be open to traffic within a year or so. Hence the problem—how to get this traffic through Baltimore. Also, the answer, the Orleans Street Viaduct, which is nothing more nor less than a facility erected to take care of traffic passing through Baltimore on the world's greatest arterial highway, in effect a double decking of a city street by the state to provide freedom of movement for the through traffic. Of use to residents of the city? Surely! In fact, of great use to them, for through streets paralleling the viaduct are not numerous. Still, primarily this is a facility built for through traffic.

Of the structural details of this viaduct, little need be said. They are made sufficiently clear by the various sketches which accompany this article. The viaduct is being constructed by the George A. Fuller Company. Construction is proceeding normally for this type of work. It cannot be fairly said that any unusual problems have been involved or that any unusual methods of construction have been required. But as an experiment in the handling of through traffic, much interest does attach to it, enough fully to warrant a close study of its effectiveness as a traffic artery by all who are interested in the problems it is expected to solve.

The viaduct itself will cost in the neighborhood of $1,000,000. It is about 2,000 ft. long and spans ten streets. Of more importance, in spanning these streets it spans some of the most congested area in the city and in so doing permits through traffic to proceed at relatively high speed in a region where but for this viaduct the travel speed could not but be low.

Approaches at each end are over streets which have not been so heavily traveled. Some of these have been widened to take care of through traffic. Others will be as occasion requires. As noted above, widening streets cannot be as effective from the standpoint of through traffic as double decking a street is. But its cost is much less. Moreover, if the streets which are selected for a through route are not already congested by city traffic, and if the route can be so laid out that it does not cross too many arteries which are congested, the result should prove quite satisfactory.

This is the solution the state of Maryland has tried to reach in its selection of approaches to this viaduct and in widening these approach streets, where necessary. The combination of well developed approaches with a viaduct of some length should prove of real benefit to through traffic and should measurably relieve congestion in the important business area of lower Baltimore.

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American Institute Steel Construction Prize Design Award

Jerome Raphael, a student at Massachusetts Institute of Technology, won first prize in the seventh annual bridge design competition held by the American Institute of Steel Construction. Alexander Matthews, Jr., a student at the Yale School of Engineering, won second prize. First Honorable Mention was given to David Hiat of New York University, and Second Honorable Mention to Fred A. Thompson, Jr., of Iowa State College.

The problem was to design a steel grade crossing elimination bridge carrying a highway over a railroad and another highway parallel to the railroad. In addition to giving the students certificates of award, the first prize carries a cash compensation of $100 and the second prize $50.

These awards were made from the ten best designs selected in a preliminary competition when ninety-four students from twenty-two colleges in the United States entered drawings. The Jury of Award consisted of Dr. Shortridge Hardesty, Mr. E. R. Needles, Consulting Engineers of New York; Mr. H. Craig Severance, Mr. J. Andre Fouilhoux, Architects of New York, and Mr. A. Lawrence Kocher, Managing Editor of *The Architectural Record*."

TRUCK TRAFFIC IN NEW JERSEY HIGHWAYS

A SURVEY of traffic on the highways of New Jersey was conducted from August, 1932, to August, 1933. Field observations were carried on at 352 observation stations located over the entire state highway system and on the principal county routes. Traffic data were recorded upon more than 1,000 sections of highway. A full report of the survey has been prepared by the U. S. Bureau of Public Roads and submitted to the New Jersey State Highway Department. The report will not be published or distributed by the Bureau. However, extracts from the report are given by L. E. Peabody, Senior Highway Economist, Division of Highway Transport of the Bureau, in the April issue of Public Roads, from which the notes following relating to truck traffic have been taken. Slightly more than half the trucks operating over New Jersey highways were owned by business organizations located in cities or towns of 2,500 inhabitants or more. Private individuals living in such urban areas owned 39 out of every 100 observed trucks. Trucks owned by persons living in rural districts or on farms represented less than 10 per cent of the truck traffic, and trucks owned by government agencies represented only a little more than 1 per cent. Table I shows the classification of trucks observed according to ownership.

The greater part of the northeast section of New Jersey is included within the New York metropolitan area. In this section trucks owned by city companies constituted a higher percentage than in any other part of the State. City companies owned about 57 out of each 100 trucks operating in this area. The companies were principally manufacturing and business organizations located within this district, but many trucks owned by New York firms as well as a smaller number owned by establishments in Philadelphia and other cities were observed. Individuals living in northeastern New Jersey cities owned 36 per cent of the trucks in the traffic sample, and were principally engaged in small businesses. Farm-owned trucks constituted about 7 per cent of trucks operating in this area which has fewer farms than any other section of the State.

The northwest section of the State is largely a farming district, and its percentage of farm-owned trucks was almost twice as great as that of the northeast section. But even in this more rural district, 86 per cent of observed trucks were city-owned.

The proportion of city-owned trucks operating in southeastern New Jersey was only slightly higher than that in the northwest section of the State, but there was a preponderance of company-owned trucks, which comprised almost 48 per cent of truck traffic in this section. About 40 per cent were privately owned. Although there are many business and industrial establishments in this district, the prevalence of company-owned trucks on its highways was partly due to the operation of trucks owned by large supply houses in New York City, Philadelphia, Camden, and other cities engaged in trucking to coast resorts. The farming industry is of considerable importance in this district and 11 per cent of the trucks operating in this section were farm-owned.

TABLE I—TRUCKS OBSERVED ON NEW JERSEY HIGHWAYS, CLASSIFIED ACCORDING TO OWNERSHIP

Class of ownership	Number	Per cent
Total, all classes	239,368	100.0
Farm ownership	22,515	9.4
Total city ownership	214,228	89.5
Company	121,463	50.7
Private	92,765	38.8
Government ownership	2,625	1.1

The extensive rural areas in Burlington, Gloucester, and Salem counties accounted for a large part of the 14 out of each 100 trucks operating in southwestern New Jersey which were farm-owned. This section had the smallest proportion of city-owned trucks, 84 per cent being of this class, and these were almost evenly divided between company and private ownership.

Owner-Operated Trucks Make Up Greater Portion of Truck Traffic.—There are three principal classes of truck operation, if the small number of Government-operated trucks is included in the owner-operated class. The owner-operated class includes those trucks, whether of company, private, farm or Government ownership, which are operated by their owners either personally or by their employees in the business of the owner. Trucks operated as contract haulers are engaged in the business of trucking for others for hire, trips being made when and where desired at rates agreed upon by the contracting parties. Trucks operated as common carriers follow established routes between definite points, operate on a regular schedule, and charge standard published rates. Throughout the entire State, owner-operated trucks constituted 79 per cent of the sample count, contract-hauler trucks 17.7 per cent, common-carrier trucks 2.2 per cent, and Government-operated trucks 1.1 per cent.

Of the total volume of truck traffic included in the sample, almost two-thirds is State and a little more than one-third interstate traffic. This means that about 66 out of each 100 trucks have both their origin and destination within the State. In the northwest section of the State 42 per cent of trucks were found to be operating in interstate traffic. This section of New Jersey lies in the path of traffic en route from central and western Pennsylvania to points in New Jersey, upper New York, or the New England States, and truck traffic between New York City and points in northern Pennsylvania, or beyond, also passes through this section. Only about 16 per cent of trucks operating in the southeast section of New Jersey are engaged in interstate traffic.

Another analysis of the figures relating to trucks engaged in State and interstate traffic, according to class of truck operation, is given in Table II. In general, contract-hauler and common-carrier trucks operated more frequently in interstate traffic than did owner-operated trucks. This classification shows that 72.5 per cent of owner-operated trucks were engaged in State traffic and that only 27.5 per cent went outside of New Jersey. Among both contract-hauler and common-carrier trucks, only about one-third were engaged in State and two-thirds in interstate operation. Of the few Government-operated trucks recorded, 90 per cent travel within the State and 10 per cent between States.

LEST WE

Washington-Richmond Road, Near Quantico, Va. 1921

Crossing Rio Puerco 21 Miles West of Albuquerque, N. Mex., November, 1911

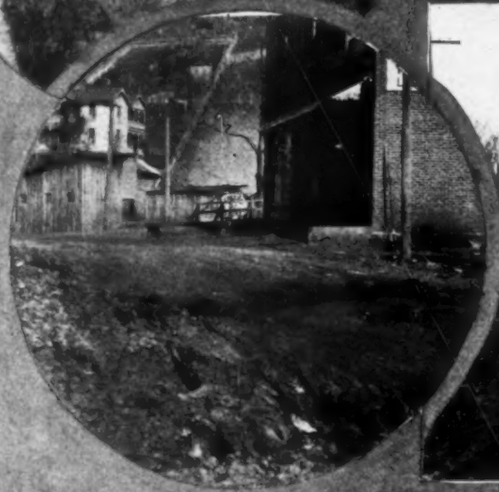
One of the Main Streets in a Town of —Hundred, W. Va., Apr

Post Road, Corduroy Road and Mud Hole, 2½ Miles North of Partlow, Va., Feb. 11, 1914

This Road Costs $15 a Mile to Improve and Transforms an Impassable Sand so 15 Miles per Hour Can Be Made Over It with an Automobile. Wilmington, N. C., March 10, 1913

Ox Team on Bad Road, Paintsville, Kentucky, Sept. 1, 1906

Massaponax-Marys Road. This Road Is Deep Sand, No Crown or Shape. Much of the Road Is Corduroy in Virginia. April 9, 1913



Bad Road—Matoaka, W. Va., 1913

Main Street in Town Looking Towards Court House, Forest, Miss., March, 1912

E FORGET!

Streets in a Town of About 1,000 Population Hundred, W. Va., April 8, 1912

Signs Put on Side of Road in Bond Issue Campaign, Forrest, Miss., March 9, 1912

Some Oklahoma Mud Near Durant. 1919

Bad Road, Seattle, Wash. Duwamish River on Left, February, 1906

Every Street in Town as Bad or Worse Than This—Checotah, Okla., January, 1912

Ford Just Below Granite Reef, Diversion Dam, Roosevelt Project, Near Phoenix, Ariz., 1913

A Gumbo Clay Road That Is to Be Made Good Within a Year in Missouri. June, 1912

Earth Road Repaired with Pine Poles, Ditch Washed Out, Undermining the Road, Stafford, Va., April, 1912

Bad Road Near the Loup River Bridge— Columbus, Nebr., September, 1912

TABLE II—STATE AND INTERSTATE TRAFFIC BY CLASS OF TRUCK OPERATION

Class of operation	Total traffic Number of trucks	Total traffic Per cent[1]	State traffic Number of trucks	State traffic Per cent[2]	Interstate traffic Number of trucks	Interstate traffic Per cent[2]
All classes, total	239,368	100.0	156,732	65.5	82,636	34.5
Owner operator	189,159	79.0	137,152	72.5	52,007	27.5
Contract hauler	42,278	17.7	15,474	36.6	26,804	63.4
Common carrier	5,273	2.2	1,715	32.5	3,558	67.5
Govt. operation	2,658	1.1	2,391	90.0	267	10.0

[1]Per cent of all classes of operation, total.
[2]Per cent of total for each class of operation, respectively.

TABLE III—NATURE OF TRUCK LOADS CARRIED

Nature of load	Number of trucks	Percentage of all trucks	Percentage by groups
All trucks, total	239,368	100.0	.....
No commodity or commodity not classified	82,328	34.4	100.0
Running empty	76,499	32.0	92.8
Carrying passengers	5,338	2.2	6.5
No load capacity	368	.1	.5
Loaded, commodity not classified	123	.1	.2
Commodity specified, total	157,040	65.6	100.0
Manufactured products, wholesale delivery, etc.	87,437	36.4	55.7
Agricultural products	32,002	13.4	20.4
Retail delivery	17,595	7.4	11.2
Products of mines (coal, oil, etc.)	9,277	3.9	5.9
Household goods	5,156	2.2	3.3
Forest products (lumber, trees, shrubs, etc.)	4,073	1.7	2.6
State highway construction materials, etc.	1,182	.5	.7
Valuables, mail, armored cars, etc.	318	.1	.2

Trucks Classified According to Commodities Hauled.—Thirty-two per cent of all trucks included in the New Jersey sample were running empty; 2.2 per cent carried passengers; 65.7 per cent carried commodities; and 0.1 per cent had no load capacity, the latter group including chassis, tractors, or other vehicles without bodies designed for hauling loads. The loads carried by trucks were classified according to fixed commodity groups and the results are shown in Table III.

The loads of trucks classified according to type of operation are presented in Table IV. Among trucks of the owner-operated class, 33 per cent were found to be running empty, in contrast with about 30 per cent of contract-hauler trucks, and only 12 per cent of common-carrier trucks. Relatively more owner-operated trucks were found carrying passengers. It appears that there is less waste of truck capacity in common-carrier and contract-hauler operation than in owner operation. Owner-operated trucks carried a greater percentage of agricultural products, retail delivery, coal, oil, and forest products than either of the other two classes. In hauling these commodities the truck is usually loaded at a fixed point, deliveries are made, and the truck returns empty to the point of origin. In both contract and common-carrier hauling, on the other hand, trips are planned so as to have the truck loaded on both the outgoing and return trip whenever possible.

As shown in Table V, approximately 66 out of each 100 trucks were expected to bring back a return load; 31 were expected to return empty; 3 were not expected to return; and only 6 per 1,000 were expected to carry passengers, or had no load capacity.

Capacity of Trucks Studied.—Trucks observed in this survey were of many kinds and capacities, ranging from small roadsters of only a fraction of a ton capacity used for local light delivery to large trailer vans used for long-distance hauling. In order to reduce this great variety of sizes to a few comparable groups, trucks have been classified as light, medium, and heavy. Light trucks include all trucks of 1½ tons capacity and under; medium trucks include all trucks of capacities between 1½ and 5 tons; and heavy trucks include all trucks of 5 tons capacity and over. For the entire State, light trucks, including passenger cars used for delivery or other hauling, comprised 55.5 per cent; trucks of medium capacity comprised 23.3 per cent; and heavy trucks comprised 21.2 per cent of the total.

It may be interesting to compare the capacities of trucks making up New Jersey traffic during 1932-33 with similar data compiled for other States during previous years. A survey of transportation on the State highway system of Ohio made in 1926, showed that 71.8 per cent of all trucks were light capacity; 26 per cent were medium capacity; and 2.2 per cent were heavy capacity. The composition of New Jersey traffic is definitely affected by the large amount of heavy hauling to or from New York City and Philadelphia which lie at the termini of the principal traffic arteries of the State.

A survey of traffic on the Federal-aid highway system of 11 Western states was made during 1929-30 by the Bureau of Public Roads and the highway departments

TABLE IV—NATURE OF LOAD CARRIED BY CLASS OF TRUCK OPERATION

Nature of load	Three classes of operation Number	Three classes of operation Per cent	Owner operator Number	Owner operator Per cent	Contract hauler Number	Contract hauler Per cent	Common carrier Number	Common carrier Per cent
All kinds, total	236,710	100.0	189,159	100.0	42,278	100.0	5,273	100.0
Running empty	76,034	32.1	62,840	33.2	12,500	29.7	625	11.9
Carrying passengers	5,006	2.1	4,831	2.6	158	.4	17	.3
No load capacity	354	.2	311	.2	43	.1	....	....
Loaded, commodity not specified	101	(1)	90	(1)	11	(1)	....	....
Commodity specified, total[2]	155,215	65.6	121,087	64.0	29,497	69.8	4,631	87.8
Manufactured products, wholesale delivery, etc.	86,624	[2]55.8	63,137	[2]52.2	19,297	[2]65.4	4,190	[2]90.5
Agricultural products	31,462	[2]20.3	26,117	[2]21.6	5,118	[2]17.4	227	[2]4.9
Retail delivery	17,617	[2]11.3	17,246	[2]14.3	323	[2]1.1	48	[2]1.0
Products of mines, coal, oil, etc	9,094	[2]5.9	7,853	[2]6.5	1,162	[2]3.9	79	[2]1.7
Household goods	5,100	[2]3.3	2,694	[2]2.1	2,442	[2]8.3	64	[2]1.4
Forest products, lumber, trees, shrubs, etc	4,039	[2]2.6	3,670	[2]3.0	360	[2]1.2	9	[2].2
State highway construction materials, etc	982	[2].6	414	[2].3	558	[2]1.9	10	[2].2
Valuables, mail, armored cars, etc	297	[2].2	56	(1)	237	[2].8	4	[2].1

[1]Less than 1/10 of 1 per cent.
[2]Based on number of trucks for which commodity carried was specified.

TABLE V—NATURE OF RETURN LOAD BY CLASS OF TRUCK OPERATION

Nature of return load	Three classes of operation		Owner operator		Contract hauler		Common carrier	
	Number	Per cent[1]	Number	Per cent	Number	Per cent	Number	Per cent
All kind, total	236,710	100.0	189,159	100.0	42,278	100.0	5,273	100.0
Returning empty	72,612	30.7	57,688	30.5	14,080	33.3	844	16.0
Not returning	6,743	2.8	5,277	2.8	1,466	3.5	....	....
Carrying passengers	1,035	.4	872	.5	67	.2	96	1.8
No load capacity	369	.2	327	.2	42	.1	....	....
Returning loaded, total[1]	155,951	65.9	124,995	66.0	26,623	62.9	4,333	82.2
Commodity not specified	142,430	[1]91.3	114,327	[1]91.5	24,336	[1]91.4	3,767	[1]86.9
Commodity specified	13,521	[1]8.7	10,668	[1]8.5	2,287	[1]8.6	566	[1]13.1

[1]Based on number of trucks returning loaded.

TABLE VI—PERCENTAGE DISTRIBUTION OF TRUCKS IN VARIOUS STATES BY CAPACITY

State	1½ tons and under	From 1½ to 5 tons	5 tons and over
	Per cent	Per cent	Per cent
New Jersey, 1932-33	55.5	23.3	21.2
Ohio, 1926	71.8	26.0	2.2
11 western States, 1929-30	67.9	26.3	5.8
Arizona	64.7	31.8	3.5
California	58.6	30.2	11.2
Colorado	73.5	20.7	5.8
Idaho	72.5	20.8	6.7
Nebraska	74.4	24.1	1.5
New Mexico	79.8	18.7	1.5
Nevada	66.1	25.8	8.1
Oregon	63.1	30.9	6.0
Utah	77.2	20.1	2.7
Washington	64.6	27.0	8.4
Wyoming	78.3	19.9	1.8

of the respective states. Nebraska, all the Mountain states except Montana, and the Pacific states were included in this survey. The classification of truck traffic of each of these states, according to the same capacity groups as those used for New Jersey, is presented in Table VI.

A grouping of the truck capacities in New Jersey and the Western states according to the percentage of farm and village ownership, as opposed to city ownership, indicates that the percentage of lighter trucks tends to increase with an increase in the percentage of farm and village ownership, while medium and heavy-capacity trucks increase with an increase in city ownership, as shown in Table VII. California stands alone as group 1, since it is the only one of the 11 western states for which the classification of trucks by ownership shows one-third farm and village owned and two-thirds city owned. The second group is made up of Oregon, Utah, Arizona, Washington, Idaho, and Colorado, the relative percentages of ownership varying from about 40 to 60 per cent farm and village ownership, with an average of 53.7 per cent. The third group consists of Nebraska, New Mexico, Nevada, and Wyoming, for which the percentages of farm and village ownership range from 60 to 80 per cent, with an average of 70.4 per cent.

TABLE VII.—PERCENTAGE OF LIGHT AND MEDIUM AND HEAVY TRUCKS COMPARED WITH PERCENTAGES OF CITY AND FARM AND VILLAGE OWNERSHIP.

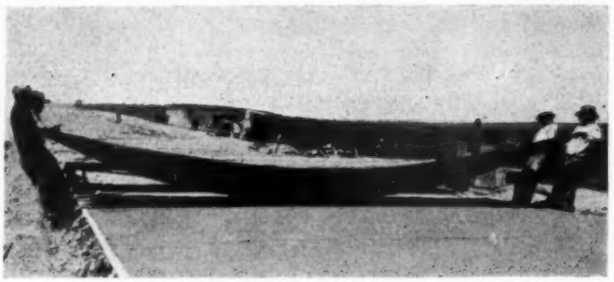
	Average percentage of ownership		Average percentage of trucks	
	Farm and village	City	Light	Medium and heavy
New Jersey	9.5	90.5	55.5	45.5
Western States:				
Group 1	33.9	66.1	58.6	41.4
Group 2	53.7	46.3	69.3	30.7
Group 3	70.4	29.6	74.7	25.3

One-half of Trucks Make One or More Trips a Day.—The frequency of trips made by trucks over New Jersey highways ranged from a maximum of more than 10 trips a day to a minimum of only one trip at intervals of more than 30 days, as shown in Table VIII. Exactly one-half of the trucks made one trip or more a day, while the other half made trips at longer intervals. Of each thousand trucks observed 413 made one trip a day, 79 made from 2 to 5 trips a day, 7 made from 6 to 10 trips a day, and only 1 made more than 10 trips a day.

TABLE VIII.—FREQUENCY OF TRIPS BY CLASS OF TRUCK OPERATION.

Trip frequency group	3 classes of operation		Owner operator		Contract hauler		Common carrier	
	Number	*Per cent*	*Number*	*Per cent*	*Number*	*Per cent*	*Number*	*Per cent*
All frequencies, total	236,710	100.0	189,159	100.0	42,278	100.0	5,273	100.0
More than 10 trips a day	251	.1	109	.1	133	.3	9	.2
6 to 10 trips a day	1,685	.7	1,157	.6	518	1.2	10	.2
2 to 5 trips a day	18,598	7.9	16,049	8.5	2,353	5.6	196	3.7
One trip a day	97,681	41.3	76,725	40.6	17,754	42.0	3,202	60.7
One trip every 2 days	33,354	14.1	25,418	13.4	7,037	16.6	899	17.0
One trip every 3 days	36,352	15.4	28,895	15.3	6,879	16.3	578	11.0
One trip every 4 days	1,197	.5	1,023	.5	160	.4	14	.3
One trip every 5 days	479	.2	386	.2	84	.2	9	.2
One trip every 6 days	780	.3	674	.4	104	.2	2	(*)
One trip every 7 days	38,203	16.1	32,108	17.0	5,784	13.7	311	5.9
One trip every 8 to 14 days	4,505	1.9	3,676	1.9	802	1.9	27	.5
One trip every 15 to 30 days	3,524	1.5	2,852	1.5	656	1.6	16	.3
Trips more than 30 days apart	101	(*)	87	(*)	14	(*)	...	...

*Less than 1/10 of 1 per cent.



Placing Cotton Mats on Finished Concrete, NRH 66, Highway No. 2, Comal County

COTTON MATS FOR CURING CONCRETE

Data from Two Years of Experiments by Texas State Highway Department

By J. G. ROLLINS

Division Engineer, Texas State Highway Department

FOR several years Mr. Gibb Gilchrist, Texas State Highway Engineer, has observed an almost exclusive use of imported burlap in connection with the wet-earth and ponded-water methods of curing concrete pavement, while there was a surplus of native cotton. He believed home grown cotton could be made into mats and used efficiently and economically in lieu of imported burlap and wet-earth, or ponded-water. Therefore, in January, 1933, Mr. Gilchrist, had some cotton mats made and forwarded to the laboratories of the Bureau of Public Roads in Washington, for tests to determine their efficiency in curing.

A detailed and favorable report was published in the July 1933 issue of "Public Roads" magazine. The efficiency of the cotton mats in insulating against temperature changes in the concrete during its setting period was emphasized in that report.

The matter of comparative costs of curing with cotton mats then came for solution. The cooperation of cotton mill and manufacturing industries was solicited in the designing and manufacturing of a few mats for experimental purposes to determine in particular the number of times the mats would stand placing on pavement for curing and the cost of handling and keeping them dripping wet on the projects. The cotton goods manufacturers very kindly made and donated 7 mats to the Texas State Highway Department for making these cost tests.

The Tests—In December, 1933, these cotton mats were placed for the first time on U.S.P.W. NRH 40, Highway No. 2, north of Temple in Bell County, the concrete pavement of which was then under construction. They were used along with the 10 day wet-burlap-wet-earth method of curing as specified in that contract. The mats were placed on a section of freshly finished pavement and kept dripping wet for a minimum of 72 hours, then moved forward and placed on another freshly finished section of pavement, and so on until the project was completed. All 7 mats were kept together at all times. The pavement between the cotton-mat cured sections was cured with wet-burlap-wet-earth.

The mats were used continuously on this project and on the adjoining State Project No. 64—reopened until they were finished on May 8, 1934, and served on 21 placements.

They were then dried on the pavement and stored in the basement of a building on a concrete floor, and remained there until June 13, 1934, when they were shipped by motor freight to Gonzales County, to be used on State Project 982-C, Highway 3-A, from Waelder to the Caldwell County Line, 16 miles in length, which was then being prepared for the starting of concrete paving.

On June 25, 1934, the 7 mats were saturated with water and placed on freshly poured concrete of this project for the first time. Throughout this project they remained at a placement on the pavement a minimum of 72 hours and were moved forward. When the mats were removed some of the pavement was sprinkled with water for 3 days thereafter, and some was not. No difference in the appearance nor the compressive strength of the pavement could be found.

Other Methods of Curing Used—Eight other methods of curing were used on this project along with that of the cotton mats as follows:

3. 12-ounce cotton sheets, double thickness, kept dripping wet 144 hours.
4. 12-ounce cotton sheets, double thickness, kept dripping wet for 72 hours, sheets then removed and pavement sprinkled twice daily for an additional 3 days.
5. 12-ounce cotton sheets, double thickness, kept dripping wet for 72 hours, then removed and no subsequent sprinkling.
6. 12-ounce cotton sheets, single thickness, kept dripping wet for 144 hours.
7. 12-ounce burlap sheets, double thickness, kept dripping wet for 72 hours, burlap removed and pavement sprinkled twice daily for an additional 3 days.
8. 12-ounce burlap sheets, double thickness, kept

dripping wet for 72 hours, burlap removed and no subsequent sprinkling of pavement.

9. 8-ounce burlap sheets, triple thickness, kept dripping wet for 72 hours, then removed and pavement sprinkled with water twice daily for an additional 3 days.

10. 10-day wet - burlap - wet - earth, as per original specifications.

No advantage could be found in the 3-day subsequent sprinkling on any of the different methods after the covers were removed.

The 7 cotton mats served 19 placements on this project, from June 25 to October 6, 1934, when the 16 mile project was completed. They were then dried on the pavement and shipped by truck to S.P. 1071-A, Highway No. 2 in Bexar County, 11.644 miles in length, from Alamo Heights of San Antonio to the Guadalupe County Line, which was then under construction and being cured with cotton mats as called for in those specifications.

On Oct. 15, 1934, the 7 mats were thoroughly wetted and placed on S.P. 1071-A along with the new mats being used by the contractor. They were used on this project the same as was done on the two previously described projects, until it was completed on Nov. 13, 1934, serving 8 placements.* They were then dried on the pavement, and on November 20th they were stored in Division 15 warehouse in San Antonio, in separate rolls.

On Dec. 4, 1934, Mats Nos. 1, 2, 4, 5, 6 and 7 were removed from the warehouse, thoroughly wetted and placed along with mats belonging to the contractor on freshly poured concrete pavement on U.S.P.W. NRM 264-B, and, used as heretofore described, until that project was completed. Then they were used on U.S.P.W. NRM 459-B until it was completed, and afterwards on U.S.P.W. NRM 400-I until its completion on Feb. 27, 1935. On these three projects the mats were used a total of 10 times—which makes a total of 58 times they have been used for curing concrete pavement on 6 different projects to date, April 11, 1935.

In the November, 1934, issue of "Public Roads" a report of further tests made by the Division of Tests, Bureau of Public Roads, in Washington, on cotton mats in the curing of concrete pavement was made, which is also favorable to the mats, from the efficiency of curing viewpoint.

Comparative Strengths of Concrete—After the completion of the Bell County projects, heretofore described, cores were cut from the pavement where each individual mat was used and from the remainder of the pavement cured with 10-day wet-burlap-wet-earth. No difference could be found in the compressive strengths of the concrete cured with the different mats, nor could any be found between that cured with cotton mats and that cured with wet-burlap-wet-earth. It should be noted that there was a great amount of rainfall during the laying of pavement on those projects, which kept the wet-earth covering more uniform and thoroughly wetted than would have been the case had the wetting of the earth depended entirely upon sprinkling with a hose.

During the laying of pavement on S.P. 982-C in Gonzales County, from June 25 to Oct. 6, 1934, the weather was unusually dry and hot. As information was desired, at the earliest practical time, on how the concrete was responding to the different methods of curing, the coring machine was sent to this project in August, 1934, after approximately the first 5 miles of pavement had been laid, and a total of 57 cores were cut therefrom, taking them from pavement cured by methods 1, 3, 4, 5, 6, and 10 as heretofore described. The cores taken from pavement cured with cotton mats showed the highest compressive strengths at a maximum of 5800, minimum of 4600, and average of 5148 lb. per square inch. The cores from pavement cured with 10-day wet-burlap-wet-earth showed the lowest strength of any of the different methods at a maximum of 5030, minimum of 3690, and average of 4610 lb. All cores tested were at least 28 days of age when broken. The average of the cotton-mat cured was 538 lb. greater than that of the wet-burlap-wet-earth cured.

In February, 1935, seventy-six more cores were cut from the entire length of the 16-mile project, and from sections cured by each of the 10 different methods.

As no marked or regular difference could be detected between the strengths of the first 57 cores taken in August, 1934, and the second 76 taken in February, 1935, the maximum, minimum and average strengths were taken from the total number of cores cut from the pavement cured by the different methods and tabulated as shown in Table I.

By taking the total cores cut from both the cotton-mat cured, with 3 days subsequent sprinkling, and that without subsequent sprinkling, the maximum was 5800, the minimum 3970, and average 4953 lb.; while the maximum, minimum and average of the 10-day wet-burlap-wet-earth cured were 5030, 3690 and 4587 lb. respectively; or a difference in the averages of 366 lb. in favor of the cotton-mat cured, as shown in Table I.

In Comal County, a short distance on State Highway No. 2 north of the previously described S.P. 1071-A in Bexar County where the concrete pavement was cured entirely with cotton mats for 72-hour minimum periods between the dates of Oct. 15 and Nov. 16, 1934, two projects of concrete pavement, S.P. 21-C and 21-F, were laid between the dates of May 28 and July 31, 1934, and cured with 10-day minimum periods of wet-burlap-ponded-water. The comparative data on the compressive strengths of cores cut from the Comal County ponded-water cured and those cut from the Bexar County cotton-mat cured pavements is shown in Table II.

It is noted that the maximum, minimum and average strengths of the ponded-water Comal County projects were 5080, 2880 and 4097 lb. respectively, while those of the Bexar County cotton-mat cured project were 5840, 2720 and 4438 lb., or a difference in average compressive strength of 341 lb. per square inch in favor of the cotton-mat cured pavement.

It is also noted that the Comal County ponded-water cured pavement had 4.2 sacks of cement with 8.0 gal. of water per sack and the Bexar County cotton-mat cured had 4.0 sacks of cement with 7.6 gal. of water per sack of cement.

Life of Cotton Mats—As previously stated, the paramount object of the experiments made with the 7 cotton mats was to determine the number of square yards of pavement a mat would cure before wearing out. To date they have been used on the folowing number of placements:

	Number of Placements
Mat No. 1	58
Mat No. 2	58
Mat No. 3	39
Mat No. 4	54
Mat No. 5	54
Mat No. 6	54
Mat No. 7	54

*Mat No. 3, the cover cloth of which was made of a low grade cotton woven loosely, with large threads running across the mat and fine threads running longitudinally, became unserviceable after it had been used once on this project—making a total of 39 placements for it.

TABLE I.—TEXAS STATE PROJECT NO. 982-C, HIGHWAY NO. 3-A, GONZALES COUNTY, SHOWING COMPARISONS OF CORE STRENGTHS AND COSTS ON ENTIRE 16-MILE PROJECT

Method of Curing Employed No.	Description	Total Lin. Ft. Employed on Entire Project	Conc. Laid Between Dates of	No. Cores Tested	Conc. Compr. Strength cr. in lbs. per sq. in. Max.	Min.	Avg.	Cost of Curing per Sq. Yd. of Pavement
1	Cot. Mats Wet 72 hrs.—with subseq. spr....	845	6-25-34 to 9-21-34	14	5800	3970	4891	3.4 ct.
2	Cot. Mats Wet 72 hrs.—no subseq. spr.....	100	8- 6-34 to 9-28-34	4	5720	4500	5170	.....
3	Doub. Cot. Shts. Wet 144 hrs.....	2,857	7-17-34 to 7-20-34	7	5560	4120	4659	.....
4	Doub. Cot. Shts. Wet 72 hrs.—with sub. spr.	55,615	6-25-34 to 9-26-34	54	5970	3500	4710	2.94 ct.
5	Doub. Cot. Shts. Wet 72 hrs.—no sub. spr..	9,689	8- 6-34 to 10- 2-34	11	5620	3660	4450	.....
6	Sing. Cot. Shts. Wet 144 hrs.....	6,791	7- 9-34 to 7- 9-34	14	5940	3680	4669	3.6 ct.
7	Doub. Burlap Wet 72 hrs. with sub. spr....	2,882	8-15-34 to 9-24-34	12	5050	3550	4473	3.0 ct.
8	Doub. Burlap Wet 72 hrs.—no sub. spr.....	612	10- 2-34 to 10- 2-34	4	5610	3690	4370	.....
9	Trip. 8-oz. Burlap Wet 72 hrs. with sub. spr.	408	8- 1-34 to 8- 1-34	4	5090	4220	4550	.....
10	10-day Wet-Burl.-Wet-Earth	4,393	7-13-34 to 8-15-34	9	5030	3690	4587	4.0 ct.

Cement factor .....4 sacks per cu. yd.
Water factor .....6.9 gals. per sack cement
Type of finishing machine.....ord., gas electric

All the mats except No. 2 were made of sufficient length to hang over the edges of pavements for curing the edges. On the Gonzales project, where cotton sheets were used principally for curing, earth was banked against the edges and level with the top of pavement. Hence approximately 1 ft. of each end of all the mats except No. 2 rested on the wet dirt, which caused those ends to rot.

As the wet mats were placed on the pavement by a man holding them up at each corner, the rotted places at the ends soon began to tear. No 2 mat, which was too short for the ends to rest on the wet dirt, is still in good condition and can probably be used 15 or 20 more times, or on a total of 75 placements. It is thought that, had the ends of mats 1, 3, 4, 5, 6, and 7 not laid on the earth-banked shoulders in Gonzales County they would also give considerably more service. Those mats were 15 ounces per square yard heavier, when new and dry, than the present prescribed mats, and mat No. 2 was 5 ounces lighter.

For the above mentioned reasons Mat No. 2 is the only one illustrated here. Defects are found in this mat which can be corrected without appreciably additional cost.

Comparative Costs of Curing—As only approximately a total of 850 lin. ft. of the pavement in Bell County was cured with cotton mats, the cost in comparison with the regular wet-burlap-wet-earth method on the remainder of the project was approximate. The data kept by the resident engineer showed the cotton mats, if they had been used extensively on the project (and estimated to withstand 50 placements), would have cost about the same as the wet-burlap-wet-earth, per square yard of pavement, on these projects.

Cost data was kept by the resident engineer on the Gonzales County project. In view of 10 different methods of curing being employed on this project, the costs as shown in Table I are not exactly representative of what would have been had one of those methods been used exclusively on the 16-mile project. The life of the cotton mat was estimated at 50 placements.

On the 11.644-mile Bexar County project cotton mats were used exclusively for curing. Accurate data was kept on the cost, which averaged 3 cents per square of pavement cured, estimating the life of the cotton mats at 50 placements.

In figuring the costs of curing, per square yard of pavement, no storage nor expense of moving the mats from one project to another has been included.

Data kept by the Division Engineer on a 15.3-mile project in Jasper County, laid during the past fall and winter where cotton mats were used entirely, shows the cost to be 2.62 ct. per square yard of pavement.

Discussion of Efficiency—As stated, the object of making the tests with these 7 mats was to determine the number of square yards of pavement a mat would cure before wearing out, in order that the cost might be determined, efficiency observations and data were also made, in comparison with the wet-burlap-wet-earth and the wet-burlap-ponded-water methods.

On the heretofore described Gonzales County project the different methods employed followed one another in

TABLE II.—COMPARISONS OF CORE STRENGHTS AND COSTS OF DIFFERENT METHODS OF CURING ON DIFFERENT PROJECTS

Method of Curing Pavement	County	Project No.	Length in Miles	Dates Poured	No. Sacks Cement per Cu. Yd.	No. Gals. Water per Sack of Cement	No. of Cores Tested	Minimum Strength in lbs. per sq. in.	No. Cores Less Than 3500 lbs. per sq. in.	Strength in lbs. per sq. in. Max.	Avg.	Avg. Cost per Sq. Yd.
Cotton Mats, 72 hrs.	Bexar	S.P. 10-71-A	11.6	9-12-34 to 10-27-34	4.0	7.6	63	2720	6	5640	4438	3.0 ct.
Double 12-oz. Cotton Sheets, 72 hrs.	Guadalupe	USPW NRH-73	3.19	10-10-34 to 10-27-34	4.2	8.0	18	3160	1	5230	4314	.....
Double 12-oz. Cotton Sheets, 72 hrs.	Comal	S.P. 21-H	.24	10-27-34 to 10-29-34	4.2	8.0	3	3600	0	5460	4280	.....
Wet Burlap 10 hrs. and Ponded Water 10 days	Comal	S.P. 21-C	5.13	5-28-34 to 7-10-34	4.2	8.0	37	2880	4	4950	4020	3.4 ct.
Wet Burlap 10 hrs. and Ponded Water 10 days		S.P. 21-F	2.91	7-12-34 to 7-31-34	4.2	8.0	18	3410	2	5080	4254	3.4 ct.

several different places in such a way that the method of curing was the only known difference involved. Hence it appears that the difference in the compressive strengths of the cores cut therefrom can conservatively be attributed to the difference in the method of curing employed.

In determining the reason for the maximum and minimum strengths of the cotton-mat cured being higher and the average being 366 lb. higher than the pavement cured with wet-burlap-wet-earth, the following should be borne in mind:

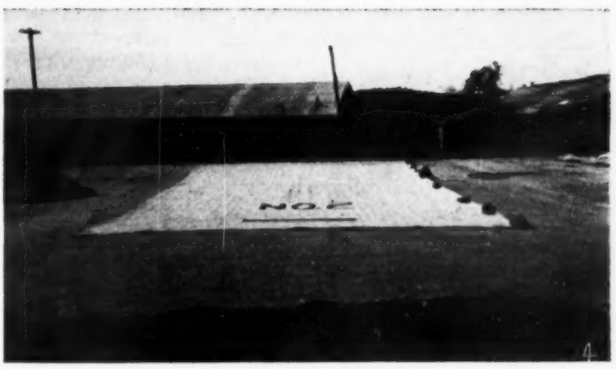
1. The cotton-mats were placed on the finished pavement shortly after the time that single thickness burlap sheets were placed, without appreciably marring the surface, and remained thereon, kept dripping wet without interruption until the end of the 72-hour curing period. The burlap sheets remained in place until after the concrete had taken its final set or until 10 o'clock of the following morning. It has been found that it is difficult to keep burlap sheets dripping wet on the pavement. Hence the pavement is more efficiently protected, during its critical period of reaching its final set, from both loss of its moisture and from temperature changes by cotton mats than it is when covered with burlap sheets. (The greater efficiency of cotton-mats in comparison with burlap sheets in heat insulation was brought out in the previously mentioned Bureau of Public Roads Tests Report of July, 1933.)
2. The burlap was removed from the pavement after its final set, sprinkled with water and covered with earth which was then sprinkled with water. No matter how diligently this is done, the concrete is endangered during this critical time to loss of its moisture, in spots at least, and, no doubt, to uniform temperature changes.
3. It is difficult, if not impractical, to know that the earth covering sprinkled with water from time to time is kept wet next to the surface of the concrete. The moisture content of the cotton-mats can be inspected at a rapid rate by walking over them. If free water appears around the soles of the shoes the mats are sufficiently wet; if it does not, they should be resprinkled.

Referring to the data of Table II, which shows the average strength of the cotton-mat cured Bexar County 4-sack concrete was 341 lb. per square inch higher than the 4.2-sack concrete cured in Comal County with wet-burlap-ponded-water. As these were two different projects there may be factors other than the curing which have a bearing on the relative compressive strengths. Nevertheless it is probable that the foregoing comments made on the Gonzales County project relative to the comparative efficiencies of cotton-mats and burlap sheets during the critical setting period of the concrete and the danger of exposure during the period from the removal of burlap to the ponding of water or the pavement may have a bearing on these relative concrete strengths.

Observations made to date show a great deal more water is required to keep burlap sheets dripping wet than is required for cotton-mats, even though the burlap is laid in double or triple thicknesses.

Cotton-Mat Specifications—The following specifications are now being used by the Texas State Highway Department for curing with cotton mats:

As soon as the concrete pavement has been finished as prescribed, and as soon as, in the judgment of the Engineer, the concrete has set sufficiently that the surface will not be marred, the surface of the pavement shall be completely covered with thoroughly saturated cotton mats, in such a manner that the cotton mats will contact the surface of the pavement equally at all points.



Cotton Mat No. 2 Used for Curing Concrete Pavement on 6 Different Projects from December, 1933, to March, 1935. Placed on Pavement 58 Times, Kept Dripping Wet on Each Place for a Minimum of 72 Hours, and Was Wet for a Total of 352 Days

The cotton mats shall be kept dripping wet and shall remain on the pavement for a period of at least 72 hours, unless the Engineer orders the pavement opened to traffic at an earlier time. The cotton mats when placed on the pavement, or raised at any time during the curing period, shall drip water.

The cotton mats shall meet the following requirements:

Each mat shall have a finished width of approximately five feet six inches (5'6") and a length two feet greater than the width of the pavement to be cured—after the mat has thoroughly shrunk. (The mats shall be made sufficiently oversize in both length and width to allow for shrinkage in use.)

The mats shall be composed of a single layer of cotton filler completely enclosed in a cover of cotton cloth.

The cotton filler shall be of low grade cotton, cotton linters, or such cotton waste as comber noils or card flat strips.

The mats shall contain not less than three-quarters (¾) of a pound of cotton filler per square yard of mat, uniformly distributed.

The cotton cloth used for covering material shall be osnaburg weighing not less than six and three-tenths ounces (6 3/10) per square yard.

The cover for each side of the mat shall be of two (2) widths of cloth joined by a strongly stitched lapped seam. The sides of the cover shall be fastened together along both edges and the ends by means of strongly stitched seams.

All mats shall be stitched longitudinally with continuous parallel rows of stiching at intervals of not more than four inches (4"), or shall be tufted both transversely and longitudinally at intervals of not more than three inches (3"). The sewing or tufting shall not be done so tightly that the mat will not contact the surface of the pavement at all points when saturated with water.

To insure the complete covering of the pavement where the mats fit together, there shall be a flap extending all along one side of each mat. This flap shall be composed of two thicknesses of the cover material and shall be approximately six inches (6") wide. The flap shall be strongly stitched along the edge so that it will lie flat on the pavement.

Conclusions—Although the foregoing costs per square yard of pavement cured with cotton mats does not include storing that might be necessary from time to time until their life is expended, and moving them from one project to another, a life of 50 placements has been used. The experiments show they will stand probably 50 per cent more, or a total of 75 placements. (One contractor advised he bought his cotton-mats with a 100-placement guarantee by the manufacturer.) It should also be noted that no attempt was ever made to clean or repair these 7 mats. When they were dried after a project was completed, considerable amounts of the dust and cement that had collected in them could have been removed, which would have decreased their weight and prolonged their lives. These mats were figured at a first cost of $6.00 each. Lower prices have recently been made on mats as now specified, and it is reasonable to anticipate even lower prices as the quantity of mats used is increased.

In comparison with the 10-day wet-burlap-wet-earth and ponded-water method of curing, the advantages now seen in curing with the cotton mats for 72 hours are as follows:

1. Cotton mats have produced a higher compressive strength in the concrete.
2. In the long run the cotton-mat method costs no more and probably less per square yard of pavement cured.
3. The curing with cotton mats is more uniform, as a film of water is constantly held over the entire surface of the slab, which can easily be inspected at all times. (It is difficult, if not impractical, to determine whether or not the earth covering is uniformly wet next to the pavement.)
4. Where wet burlap is replaced by earth covering and wetted, or by earthen levies and ponded-water, there is a period during which the pavement is endangered to loss of its moisture and to changes of temperature, at the time it needs continuous protection therefrom. Also the earth thrown on the pavement is often more or less dry and may rob the pavement of some moisture in places. These undesirable conditions do not occur where cotton mats are used. The holding of a continuous uniform moisture and temperature in the slab during its critical setting period will no doubt reduce cracking in the concrete.
5. Where the subgrade and shoulders of roadway are constructed of selected soil it is not disturbed or contaminated with inferior soil during pavement construction where cotton mats are used.
6. Where the concrete is a base for bituminous topping, the scarified surface of concrete base is perfectly clean when the topping is applied to it, where cotton mats are used, and a better bond is obtained between the base and the topping.
7. When pavement is laid in cities where earth for covering must be hauled in and out, the mats are much more economical.
8. Where ponded water is employed there is danger of overly wetting the foundation soil at concentrated points which will non-uniformly expand a highly volumetric-change soil and cause irregularities in the pavement surface.

The costs of curing with cotton mats can be greatly reduced if their use is increased to the maximum, and an arrangement can be made whereby they are used continuously until their life is expended, eliminating as much as possible the carrying of them in storage. Several methods have been suggested.

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Approved Amendment Revises Registration Requirements in Bituminous Road Material Distributing Industry

An amendment revising the requirements for registration under the bituminous road material distributing industry's code has been approved by the National Industrial Recovery Board.

The revised provision requires members to register with the Code Authority the number and type of bituminous distributors operated or owned by them, and to display a registration insignia upon each distributor. Cost and design of the insignia are subject to approval of the NIRB.

Operation of a distributor without approved insignia, after 60 days from April 27, will be a code violation. The amendment provides for extension of the time limit if necessary for any member of the industry.

Portable Outfit for Lubrication of Construction Equipment

A simple and yet very effective installation for taking care of the strict lubrication requirements of a large construction outfit is employed by the List & Clark Construction Co. This company, operating extensively in western Kansas, experienced a great deal of difficulty with the dust and sand so prevalent in that territory these past months. Many men and much time were used in carefully lubricating the shovels, graders, dump wagons, tractors, etc. But with the hand-operated guns it was difficult to keep grit out of the bearings. The cost of operation and labor was mounting, and expensive machinery was endangered, due to poor lubrication. As a result the outfit illustrated herewith was developed.

A Multiple Unit System Installed on a Truck

The List & Clark lubrication outfit is mounted on a 1½ ton truck which carries the following: An Alemite power lubrigun, a small compressor operated by a gasoline engine, an electric light plant, oil barrels containing different grades of oil, and a storage tank for lubricant. With this outfit the company has been able to lubricate all its construction machinery at night and do a much better job.

With the truck the powergun can be rapidly driven from one machine to another, the gun applied quickly to all the fittings, and the job completed in a comparatively short time.

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A New Use for Magnet Wire

One of the large oil companies in Texas has discovered a unique use for magnet wire. The geophysical department handles very high explosives in its field work and it is imperative that each individual keep in constant communication with his base. Several men report to the same base, and the cost of stringing regular overhead telephone wire would, of course, be prohibitive.

Each man as he starts out from the base simply straps a five-pound spool of No. 24 General Electric single cotton enameled bonded magnet wire on his back so that it unwinds as he walks along. When he reaches his destination he cuts the wire, fastens it to his hand telephone, and is in immediate touch with his base.

The wire must be strong in order to withstand the strain; and it must be perfectly insulated to prevent grounding when dragged through mud and water. When the job is finished, each man disconnects his telephone and leaves the wire. The total cost of the communication system is negligible.

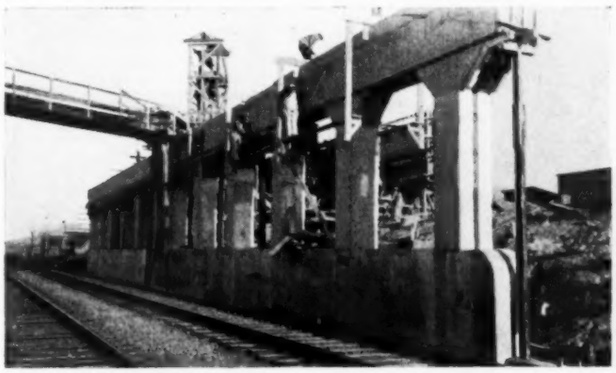
Construction View on April 14, 1935, of Grade Separation on Philadelphia Road Relocation Over Baltimore & Ohio Railroad

Grade Separation at Golden Ring, Maryland

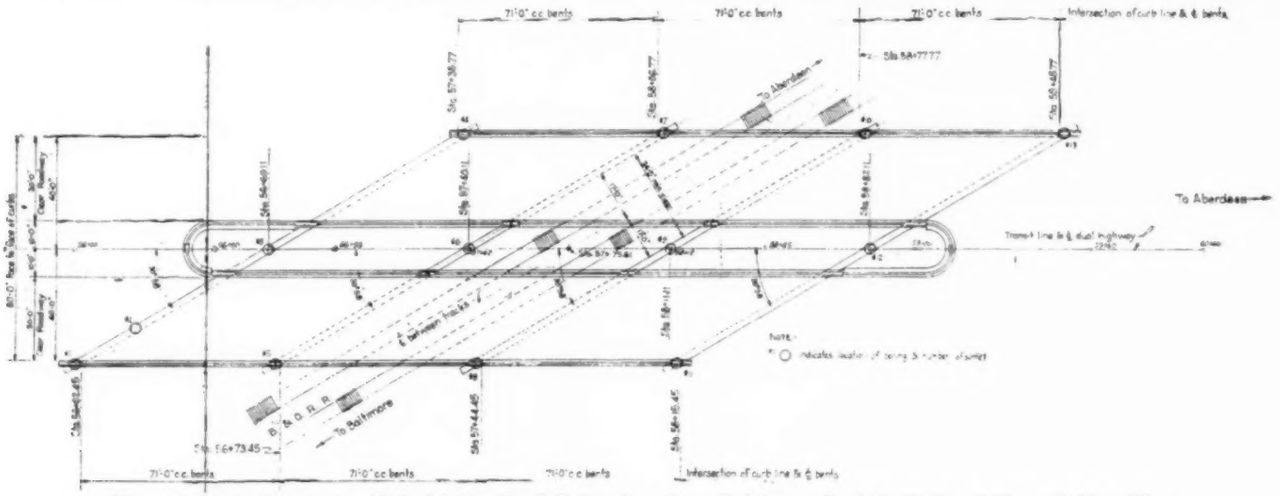
THERE is under construction at the present time a highway extending from the Baltimore city line to Havre de Grace which is known as the new Philadelphia Road. It is contemplated to continue this new highway to Elkton, where connection may be made with the Delaware State Highway System.

That portion of the highway under construction at this time is of dual type and provides two 20-ft. pavements with a parkway area of 20 ft. The new location of this road required the erection of a number of bridges, among which under construction at this time is the bridge over the tracks of the Baltimore & Ohio Railroad at Golden Ring in Baltimore County.

The new structure will provide two 20-ft. clear roadways with an open well of 20 ft. which is a continuation of the parkway area described above. The bridge consists of three spans, each 71 ft. center to center of bents, and 80 ft. between outer curbs. The end bents will be buried, while the area in the center span provides for the two main line tracks of the Baltimore & Ohio Railroad. The structure is built on a considerable skew and the crown of the roadway is on a continuous vertical curve. The substructure is of simple bent construction. The center bents contain a collision wall. The superstructure is composed of steel I-beams with a concrete deck. The exterior beams are encased in concrete for



Construction View on January 15, 1935, of Golden Ring Grade Separation



Plan of Grade Separation Philadelphia Road Relocation Over Baltimore & Ohio Railroad Near Golden Ring

Construction Views on April 14, 1935, of Golden Ring Grade Separation

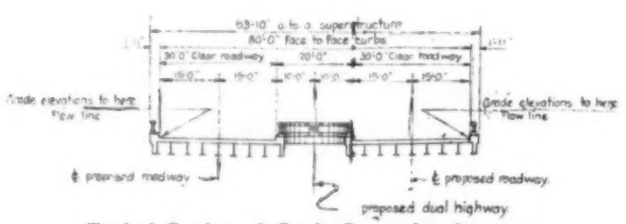
appearance. The end bents differ in design slightly to take care of certain forces from the approach fills. All of the beams over the railroad are to be united.

This type of structure has been used quite extensively by the Maryland State Roads Commission in grade elimination projects and is also the type adopted by the Baltimore & Ohio Railroad for use in structures of this type.

The approximate cost of this structure will be $107,000.

The Northeastern Construction Company, Baltimore, Md., is the contractor. The bridge is being built by the State Roads Commission of Maryland under the direct supervision of the following officials:

H. D. Williar, Jr., Chief Engineer; W. C. Hopkins, Bridge Engineer; D. P. Campbell, District Engineer.



Typical Section of Grade Separation Structure

What U. S. Chamber of Commerce Thinks About Gas Tax Diversion

The following is a copy of a statement issued last March to organization members of the U. S. Chamber of Commerce by Henry I. Harriman, President of the Chamber:

Taxes levied for highway use should be applied for highway purposes and it is now timely to provide for discontinuance of any diversions that have been made.

The membership of the Chamber have by repeated declarations supported the principle that highway users, in addition to being fully subject to all other taxes, should through special taxes pay the cost of improving and maintaining the highways of general motor use, and that the proceeds of such special taxes should be applied exclusively for highways.

The Chamber's members have further declared that the gasoline tax, which is the chief special tax, should be kept down to a point not encouraging large-scale evasion.

The principle of non-diversion of special highway-user taxes was recognized by Congress last year in the Hayden-Cartwright Act, whereby any state will be denied a third of its federal aid funds for highways if by diversion of user taxes it reduces its contribution to the federal aid system. It will assist in stopping further diversions if there is a clear understanding of the serious effect which this law will have upon future federal contributions to the highway revenues of any state making such diversions.

The reasons underlying the Chamber's position in support of the principle of non-diversion may be summarized as follows:

1. Diversion breaks faith with the highway user. He has generally accepted his responsibility for the major part of the highway bill, and this means of paying it. The money he thus pays obviously should not be put to other use.

2. Diversion creates resistance to proper and needed highway-user taxes. If the motor-using public know that the revenue from such taxes is likely to be diverted, they will not accept the burden thereof with the good will that has generally prevailed.

3. The highway program suffers unless the deficiency is made up from general taxes.

4. If, as is already the case in some states, the user taxes are so high as to make evasion profitable to unscrupulous persons, "bootlegging" of gasoline occurs on a large scale and the tax revenues suffer.

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BICYCLE PATH CONSTRUCTION IN BELGIUM—The 1934 state road improvement program of Belgium included an appropriation of 10,600,000 francs for special bicycle paths, which exist along the majority of roads in that country.

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MOTOR VEHICLE TAXES IN GREAT BRITAIN—Owners of motor vehicles in Great Britain now pay in direct taxation upon their vehicles and gasoline around $350,000,000 per year, of which only about $125,000,000 goes to the road fund, the remainder being absorbed into the general revenue of the country.

Road Building for Bicyclists in Germany

By DR. ING. SCHACHT
Berlin, Germany

IN regard to road building for bicyclists in Germany there remain many things to be done because they have been neglected in former years. Only in certain places something was done for bicyclists because they accomplished it themselves.

Now, since the General Inspector of Roads took the matter in hand much success is anticipated. There are now under construction 400 kilometers of roads and highways for bicyclists, and much more is expected to be done in the future. The great necessity for building roads has been pointed out to the Province of Prussia and to other parts of the country and great sums of money will be appropriated for the construction of these roads by the state and by local authorities. Through the initiative of the Inspector General of Roads these roads are classified as follows:

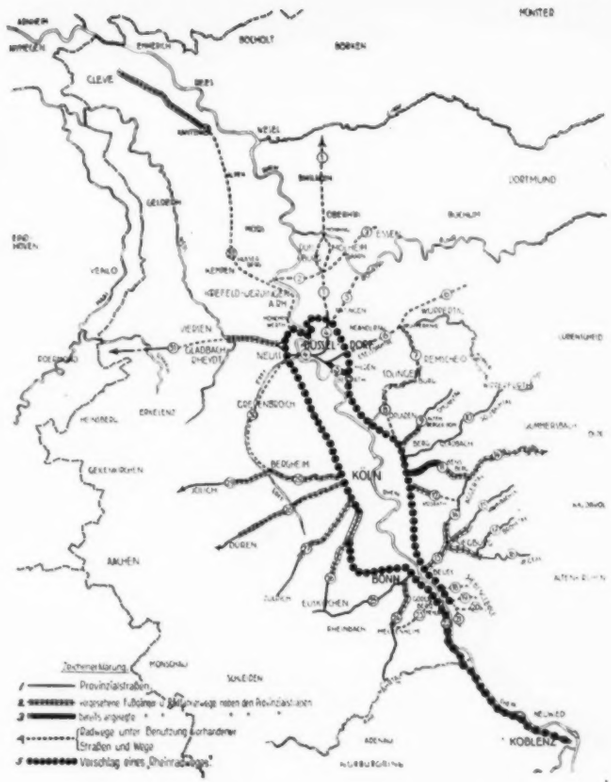
1. Roads for the use of bicyclists exclusively in order to unburden highway traffic.
2. Roads for bicyclists to unburden highways only partly.
3. Roads for the exclusive use of tourists.

Now, the question arises—is it necessary to build roads for bicyclists considering the traffic of automobiles?

In that respect Holland, Switzerland and Denmark serve as an example. In these countries every bicyclist is registered and a census has been made which indicates that in spite of the automobile the number of bicyclists has doubled within the last decade, so that in those countries every second or third person owns a bicycle (in Germany actually every 5th or 6th).

There has not always been a special road for bicyclists. On the highway they rode on the sidewalks which were sufficiently large and more convenient than the highway itself. The streets in the cities were also very good for bicyclists. When in the past somebody expressed the wish for special roads for the bicyclist it was for the purpose of protecting the pedestrians who were annoyed by bicyclists. Things became worse through the automobile and its continuously growing numbers. Through it the highway became a dangerous ground. It endanged not only the motor cars, but also the lesser vehicles, chief of these being the bicyclists. The greatest danger was caused by the difference in speed. Traffic rules were made but proved rather unsuccessful. The only method to regulate traffic is to build roads for autos and for bicyclists. For the automobile several automobile roads have already been built. The causes for the prevention of accidents not only demand the construction of those roads, but in addition thereto it has become a social question. It is essential for the promotion of health and the welfare of the public. To the workmen who use the bicycle as a quick and cheap transportation it will become dangerless. The value of the bicycle from the standpoint of "health" will be greatly enhanced through the building of these roads, because it is the only vehicle compelling the rider to take physical exercise in fresh air.

To this date there are only good roads for bicyclists in the following cities: Hamburg, Magdeburg, Stettin, Schneidemuehle, and Muenchen. A project is under way to build a road long the Rhine for tourists. In the South it will run along to the Neckar. These roads will lead through forests, along seashores, as for example in



Map Showing Roads Already Built and Contemplated for Bicycle Riding: 1, *Provincial Highways;* 2, *Roads Contemplated for Use of Pedestrians and Bicyclists Beside Provincial Roads;* 3, *Roads Already Built for Pedestrians and Bicyclists;* 4, *Roads for Bicyclists Used in Conjunction with City Streets;* 5, *Plan for Bicycle Road Along the Rhine*

Magdeburg. There is also contemplated a road toward the "Bodensee"—Freiburg and Lindau.

In Schlesien there will be a similar project, a road along the banks of the "Schlawe-Seas," which will be very convenient to the cities of Gruenberg and Glogau. The project for the roads leading to the Schlawe-Seas will be under way next year. Those planned in Upper Schleisen will be useful for tourists in the surrounding localities.

A plan has been worked out to build 3,000 kilometers of roads in Saxony. This section of the country being extremely industrial it becomes necessary to build these roads for the workmen to ride to and fro to their place of employment. Only a few examples on the road building projects are cited. In all, the mileage runs up to about 40,000 kilometers.

From the industrial standpoint it is important to favor the building of these roads because through it the production of bicycles will increase the industry and employ hundreds of thousands of workmen; then too, in building these roads they can use unskilled labor. It is therefore the aim of the different organizations and associations, the state and the communities, to further the building of roads for bicyclists.

There is a complete understanding between these bodies, governmental and local, as to the necessity for road building and to support the movement.

Attention should be called to the fact that there are in Germany every year 75,000 bicycle accidents and casualties. How much misery is connected therewith! How great the property damage! It is only through the construction of these roads for bicyclists and the separating of these roads from the other highways that these accidents are successfully averted.

EDITORIALS

Highway By-Products

"WHAT the hell does anybody care about us farmers. You fellows are just goin' to make that road cut our farm in two so a lot of rich folks from Seattle and Tacoma can come out here for a good time in their automobiles; and we've got to pay for it!" This wail (not unique) from a settler on the west shore of Puget Sound in the year 1909. His property was accessible only by primitive ponly trail and boat, but his spirit rose in indignation as he watched the state survey party setting preliminary stakes for the Olympic Highway. The young transitman tried to assure him that he would be paid for the right of way and any incidental damages, that the highway would make life pleasanter and farming easier, that it would increase the value of his property, and most important of all, that it would bring him more business than he could ever hope for otherwise. To no purpose: jealousy and a complete lack of imagination held him.

Eleven years later, on a bright Sunday afternoon, the transitman returned. Along the miles of good, smooth road he found well-remembered scenes, forgotten scenes, and scenes much changed. The protesting farmer was not there, but the old farm had been extended up the hill and had an air of prosperity foreign to the days of 1909. A little farther on he came to "Sunds Rest," and was barely able to identify it. It had been Sund's farm in the old days—one of the more prosperous farms of the neighborhood. But now farming had dropped in importance, and a small resort assumed first place. There were new buildings, lawns, and various facilities for tourist enjoyment.

The transitman talked with Sund. Yes, he was doing a lot better with the "rest" than he ever had with the farm. The road had helped him more than he had ever expected it would (Sund was among those who wanted the road from the beginning) and it had helped everybody along there.

The surveyor in 1909, trying to reassure the disgruntled farmer, glimpsed but a small part of the developments to which motor transport would lead, and so, of course, did the world at large: the favored few—the very few of keenest foresight—knew what to expect. And of the features overlooked, probably none was more general than the "by-products" of the highway. Even today, it is doubtful if many people realize the scope and the scale of this by-product business.

What *are* highway by-products? All things, we should say, which result from the presence and use of the road—filling stations, garages, road houses, refreshment stands, farmers' sales stands, tourist camps and resorts, to mention a few only.

Only partial statistics are available on these institutions, but it is worth while to consider the following for the year 1933, compiled by the National Highway Users' Conference on the basis of information furnished by the U. S. Bureau of the Census.

Filling	No. of establishments	Sales	No. of proprietors	Av. No. of full time employes	Av. No. part time employes	Total pay roll
stations	170,404	$1,531,724,000	156,451	143,391	28,421	$151,938,000
Garages	86,454	519,827,000	101,175	71,904	20,299	76,216,000
Tourist camps	5,846	8,483,000	7,921	1,705	785	1,157,000

Filling stations and garages with annual sales of two billion dollars, giving regular employment to 472,000 people and part time to 48,000 more, are a by-product of no mean size. Even the humble tourist camp assumes a new importance when we realize that it furnishes at least a part of a living to nearly 10,000 people, and does eight and a half million dollars of business a year.

These people—the owners and operators of filling stations and hot dog stands and all the other business dependent on the motoring public—have a common interest but they do not speak in common. For the most part they do not speak at all in those places where speech would help them most. Whatever is said in their interest comes from their greater and better organized allies, the petroleum and auto-manufacturing industries.

Organization of so numerous and varied a group would be difficult, but not impossible. If conducted wisely it could be made of tremendous benefit.

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What Do Advertisements Mean to You?

Have you, as a reader of articles and editorials in technical magazines and trade papers, stopped to consider the practical value to you of the advertising section of such publications?

We both know that the Saturday Evening Post is frequently purchased primarily for the information and news value of its advertising pages. The reader learns of improvements in automobiles, radio receiving sets, household and office appliances, of a new shirt with a collar guaranteed to be wilt proof. Through the news value of the ads, he keeps abreast of the times and developments which concern his every day life. As he scans the advertising pages he notes with satisfaction, that the manufacturer of his car, radio or vacuum cleaner is still telling him (and the world) how good the product is, how dependable and progressive the company is.

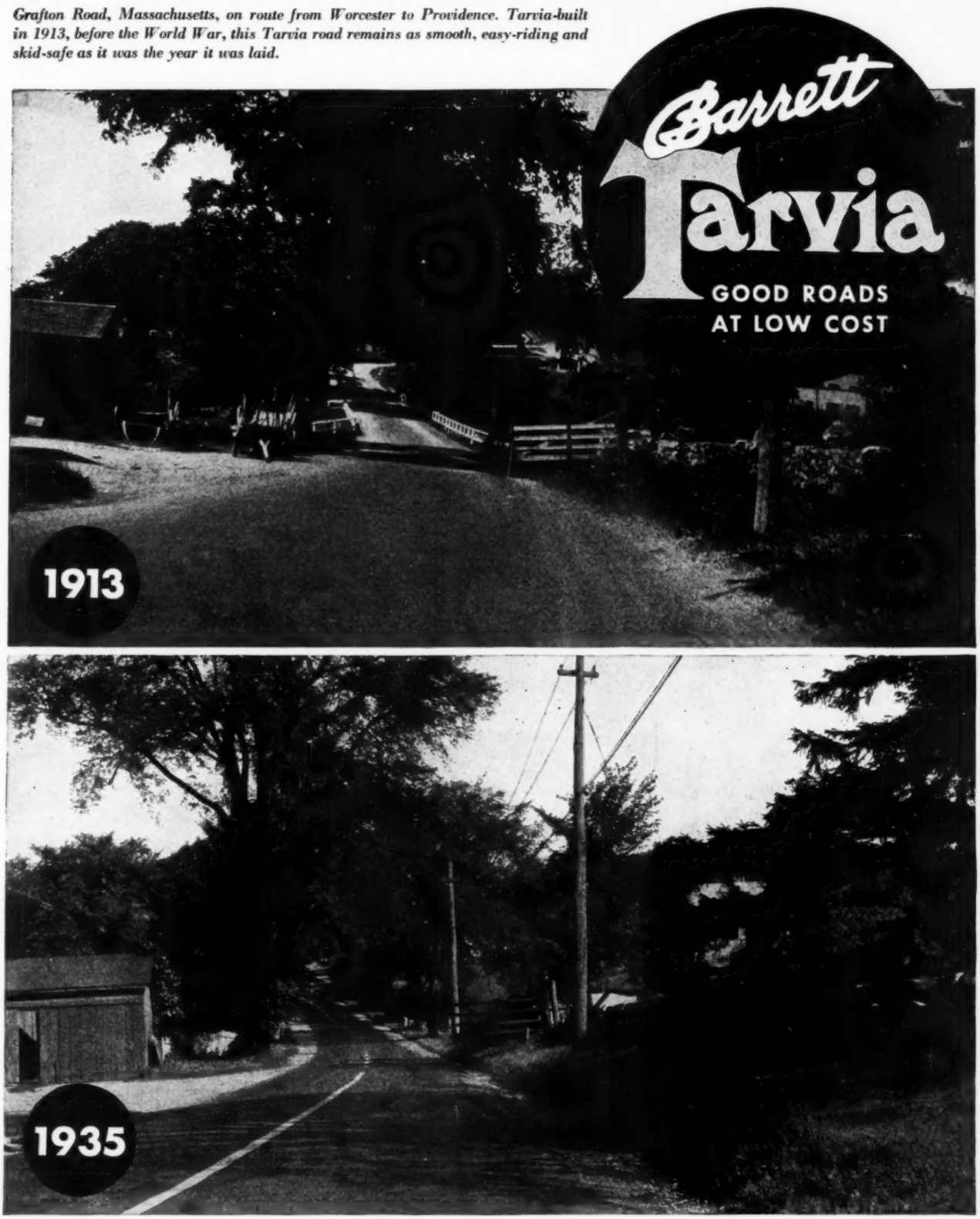
Regardless of the magazine or the field it covers, worth while advertising offers the reader the same type of values that does general advertising. News value: informativeness; creation and support of confidence; these, are the chief values possessed by technical magazine ads. More likely than otherwise an announcement of a new development will appear in the advertising section before it appears in the editorial sections of trade magazines. Advertisers usually wish to make the best use of the news element in their publicity by "breaking out" with a new development in their ads rather than elsewhere in the magazine. It creates "reader interest" in advertising copy.

Furthermore, advertisers frequently make important announcements of changes in policy, betterment of distribution or service facilities. Such important matters, to both executives and employes, are frequently learned only in the advertising section of the magazine.

Answering advertisers' offers of bulletins, reprints and hand-book can be made a profitable procedure. Printed matter offered through the technical press of today has a material value in increasing knowledge and serves as a reference source of valuable information when preserved and filed under heading of subject matter covered. At little or no expense a reference "library" of considerable value can be thus built up of catalogs, hand-books, data tables, reprinted articles and the like.

Aside from the availability of the magazine at a price far less than would be possible without the primary income derived from the advertising it contains, are you getting your full share of value from the advertisements?

Grafton Road, Massachusetts, on route from Worcester to Providence. Tarvia-built in 1913, before the World War, this Tarvia road remains as smooth, easy-riding and skid-safe as it was the year it was laid.



To road officials and highway engineers traffic-safety of a road is equally as important as its durability and low cost. Tarvia roads qualify on all counts. Tarvia penetrates deeply into the road crust, holding the stone or gravel firmly exposed on the road surface. The resulting slightly granular surface, which is characteristic of Tarvia road types, provides an effectual tread-hold for automobile tires. Let the Tarvia field man help you provide *safe* roads.

THE BARRETT COMPANY New York Chicago Philadelphia Cleveland Birmingham St. Louis Boston Minneapolis Toledo Milwaukee Detroit Baltimore Columbus Youngstown Lebanon Buffalo Providence Syracuse Hartford Cincinnati Bethlehem Rochester Portland, Me. In Canada: THE BARRETT COMPANY, LTD. Montreal Toronto Winnipeg Vancouver

NEW EQUIPMENT AND MATERIALS

New Trailer

A new 10-B trailer for carrying their 10-B excavator from job to job—over long, or short, distances; fast and economically—is now being offered by Bucyrus-Erie Co., South Milwaukee, Wis., to its 10-B shovel customers.

This trailer has front-axle steering, dual-pneumatic tires, front and rear, rear-wheel brakes, and a remarkably simple and effective loading system. In practically all states, it meets required highway regulations.

New 10-B Trailer

Only four simple stops are necessary in loading. First, the trailer front axle is disconnected. Second, the shovel moves into place over the rear assembly under its own power. Third, the trailer is re-assembled, and the frame raised into position with the built-in screw jack. Fourth, the machine is fastened by clamping the excavator axles to the trailer frame. It is then ready to go places—in a hurry.

At truck speed, over rough roads, the 10-B rides securely on the trailer, the axles of the mounting resting directly on the main frame. The traction belts are suspended outside the trailer frame, with ample clearance—10-in.—above the ground.

Overall height of the 10-B shovel mounted on the trailer is only 10 ft. 8 in., and the weight on each axle of the trailer only 10,300 lb. The loaded trailer can be turned around in a 50-ft. street without backing.

▼

New Blasting Agent

A new blasting agent for large diameter drill holes has been brought out by E. I. du Pont de Nemours & Co., Wilmington, Del. This product is known as "Nitramon." Among the several advantages claimed for it, the safety of handling and use is probably the most important. It is not an explosive in the accepted sense of the word, since it cannot be detonated by (1) one of several of the strongest blasting caps, (2) Cordeau, (3) flame, or (4) impact of a rifle bullet or of heavy steel weights such as drill bits. Its full blasting strength is developed, however, by the use of a suitable primer. As a primer of dynamite of 40%, or higher, strength in cartridge size of at least 4 in. diameter and at least 8 in. length is recommended.

Other of the most important advantages claimed for "Nitramon" may be briefly stated as follows: (1) "Nitramon" is packed in tightly sealed metallic containers and as a result its water resistance is unlimited, provided the cans are properly handled and loaded. (2) It is non-headache producing, not only because of the nature of its package, but primarily due to the fact that it contains no nitro-glycerin. (3) It is absolutely non-freezing. (4) It shows appreciable savings to the purchaser in many cases because of its exceptionally high strength.

A series of five grades of "Nitramon" is being introduced to the user under the title "Nitramon" A to E, inclusive. These grades all possess the same high strength per unit of weight. They differ only in density, that is, in bulk strength, or in strength per foot of bore hole. Grade A, with the strongest bulk, compares to 75% gelatin; Grade E, with the weakest bulk, compares to 40% ammonia dynamite; and Grades B, C and D fall in a logical series of strengths intermediate between A and E.

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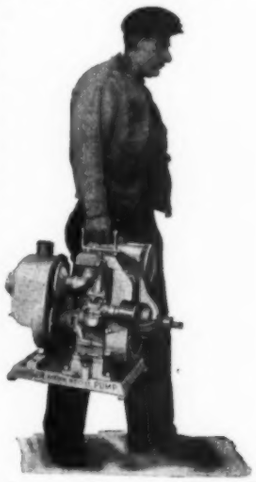
New Light Weight Portable Pump

A new light weight portable pump has been placed on the market by the Jaeger Machine Co., 223 Dublin Ave., Columbus, O. It is powered with 2½ hp. engine and rated at 8,500 gal. per hour capacity.

Weight saving has been accomplished by the compactness of design and the use of aluminum and alloy steel construction, producing a rugged, powerful outfit which is also portable enough to be picked up with one hand, carried anywhere and set to work on anything from slow seepage to continuous, big volume pumping. It is offered for general utility service to contractors, industrial users, public utilities and municipalities.



Jaeger "Bantam Weight" Pump

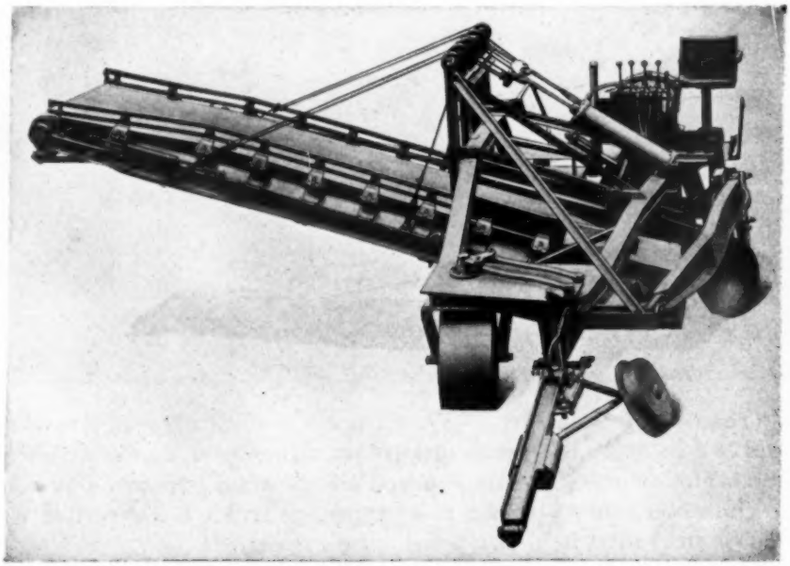
Priming action, as in all Jaeger prime pumps, is completely automatic, without hand levers or adjustments. Repriming is also automatic to keep holes dry. With a tight suction line it is stated the pump will remain primed for days. Patented self-cleaning shell design, open type impeller mounted direct on engine shaft and patented Lubri-Seal, which eliminates shaft packing, are other features.

▼

New Three-Wheel Elevating Grader

This hydraulic power operated unit provides increased capacity, regardless of the ground worked, by a novel combination of weight distribution, elevator design, plow beam control and steering, according to The Austin-Western Road Machinery Co., Aurora, Ill.

By supporting the welded, one-piece, steel frame on three



New Three-Wheel Elevating Grader

"I NOW DO 10 HOURS WORK IN 8 HOURS

SINCE CHANGING TO ZERO PRESSURE TIRES"

says Carl Anderson
Antioch Township
Antioch, Ill.

● We can show you how to cut your road maintenance costs 20% to 30%. A strong statement? Yes. But no stronger than the facts behind it.

Take the statement of Carl Anderson of Antioch, Ill., for example. "Before we put Zero Pressures on this maintainer I used to get stuck several times a week. Now I can go anywhere and always have plenty of traction.

"With solids it took 10 hours to do the work I now do in eight. Furthermore, I used 13 or 14 gallons of gasoline for the job that now takes 10."

Less Machinery Maintenance

Mr. Carl Barthel, Township Commissioner, backs up this statement. He says, "We changed this motor grader from solid tires to Zero Pressures one year ago. I find we always have plenty of traction, that there is less vibration of the equipment and that there is therefore less maintenance expense."

Can't Go Flat!

You can make similar savings. These amazing tires can't puncture—can't go flat. A giant air cavity underneath the big cleat tread cushions the load, eliminates the bouncing of air pressure tires. The lug type self-cleaning tread has 30% more traction! That's the kind of tire that gets work done in a hurry—that saves real money.

End Tire Trouble

Put an end to tire troubles on graders, mowers, maintainers and tractors. Get the revolutionary Z-P (Zero Pressure) Pneumatics.

See your Goodrich Truck Tire Dealer or write for complete information on changeovers. Address Dept. Z-10, The B. F. Goodrich Co., Akron, Ohio.

Goodrich Z-P ZERO PRESSURE Pneumatic Tires

SPECIFY Z-P PNEUMATICS ON ALL YOUR NEW EQUIPMENT

CLEAVER Heaters

show a **Profit!**

Order a **Cleaver** Heater now—the special job of heating tank cars can be done faster and cheaper with CLEAVER Heaters. Years of pioneering and development of CLEAVER Heaters have made them outstanding in efficiency and economy—there is no substitute for a CLEAVER Heater. Why take chances on makeshifts?

Write today for prices and catalog.

Department H

CLEAVER-BROOKS COMPANY

MILWAUKEE, WISCONSIN

Cleaver

TANK CAR HEATERS

***and* BOOSTERS**

wheels, the weight of full loaded elevator is counterbalanced so that 32-in. disc plow can be forced down and worked to maximum capacity.

Elevator, driven at high speed by universal shaft, gets material away from plow as fast as it is dug. Elevator is equipped with anti-friction rolls and troughed belt. This construction does not require full length side boards and only a negligible amount of friction between the material handled and elevator siding can develop to retard smooth operation. When elevator operates in average position, drive shaft is practically straight, thus reducing wear on universal joint. Bevel gearing connecting head drum with drive shaft runs in oil.

Stiff leg plow is equipped with extra strong beam and standard. Beam is arched directly ahead of plow to eliminate "choking" when handling sod or large clods. Plow can be set to "float" without affecting lifting operation. Operator can take deep cut by forcing plow down or wide shallow cut by varying position of furrow wheel from platform, while grader is in motion. Furrow wheel adjustment is hydraulically controlled.

All wheels are Timken Bearing equipped. Front wheel is carried in large, one-piece welded yoke and steered by adjustable pole through medium or large connecting links above frame deck. Short "square" turns can be made in either direction without interference; rough ground cannot impose twisting strains on frame. Right rear wheel is laterally adjustable to increase tread.

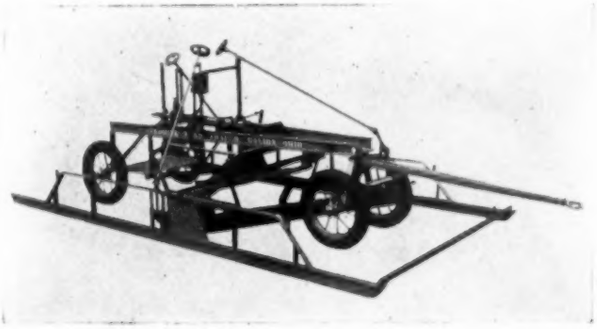
Hydraulic controls raise, lower or hold elevator and plow in any position. Pump providing power does not operate under load (or against relief valve) when elevator, plow or other members are in hold or "locked" position.

To simplify operation, save gas and increase motor life, clutch and throttle controls are connected and synchronized. Throttle closes an instant after clutch is released and opens an instant before clutch is fully engaged.

▼

New Road Shaper

A new road shaper designed to be drawn behind a 1½ ton truck at speeds up to 35 miles per hour has been brought out by the Gledhill Road Machinery Co., Marion, O. This machine is similar in general appearance to the Gledhill road adjuster,



Gledhill Road Shaper

but it is different in size and weight, has two straight edges instead of one and is more distinctly a maintenance machine.

Among the claims for the new machine are the following: The two blades being set at opposing angles eliminates side draft; the straight-edges, one on each side, keep blades true and even so that roads are shaped to a true level—bumps planed off and ruts and hollows filled, leaving a firm, even surface.

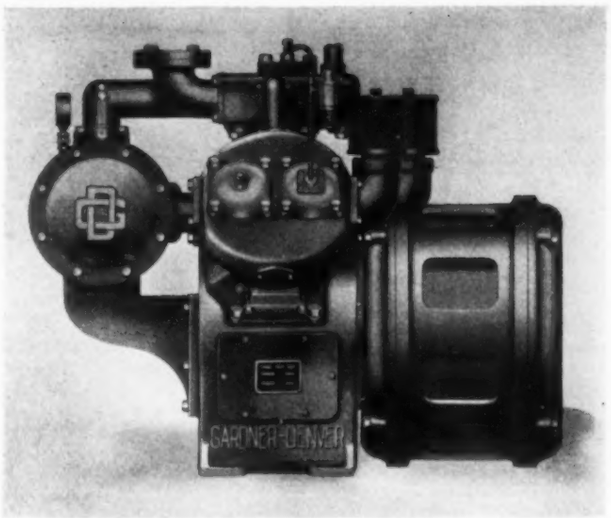
A four-wheeled chassis with pneumatic tires, hydraulic lift and Timken tapered roller bearings, helps to carry the mechanism and keep it in accurate adjustment.

▼

New 3-Cylinder Air Compressors

Available in sizes ranging from 113 to 194 cu. ft. per minute displacements, a new line of 3-cylinder air compressors, known as "WBR" has been announced by the Gardner-Denver Co., Quincy, Ill.

These new compressors, which are part of the complete WB line, are claimed to combine a number of unusual features of



New 3-Cylinder Air Compressor

design which, Gardner-Denver officials state, materially increase their efficiency and value.

One of the most distinctive features of the WBR compressor is the use of two small low pressure cylinders. Cylinder walls are water-cooled. In addition, the two-stage construction, with water-cooled cylinders and intercooler, is stated to assure sustained high efficiency.

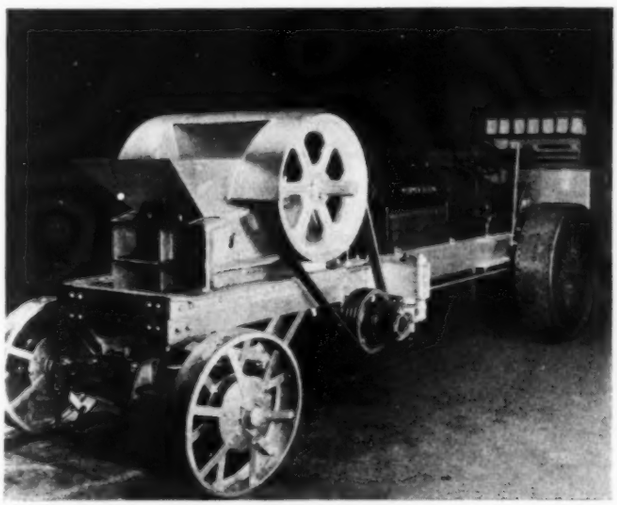
A force feed pressure lubrication system is used, oil being delivered to the bearings by a plunger pump. Pistons and cylinder walls are lubricated by the oil spray of the crank pin. The compressor may be run in either direction.

The main bearings are of the Timken heavy-duty, tapered roller type. The crank shaft itself is of chrome-nickel-molybdenum alloy, ground to size and accurately counterweighed for best running balance. Connecting rods are of drop forged steel, heat treated, having steel backed, babbitt lined, ribbon-type crank pin bearings. Pistons are of the light weight automotive type, ground to fit the cylinder bore, and three compression and one oil ring are used on each piston. Valves are of the "cushioned" noiseless automotive plate type, the cushioning being accomplished by the use of an air cushion pocket in the guard or bumper over each valve.

▼

New Portable Crushing Plant

A new portable plant in which the crusher and tractor are built into a single unit has been placed on the market by the Iowa Manufacturing Co., Cedar Rapids, Ia. The tractor fur-



Tractor-Crusher Unit, Hand Feed Type

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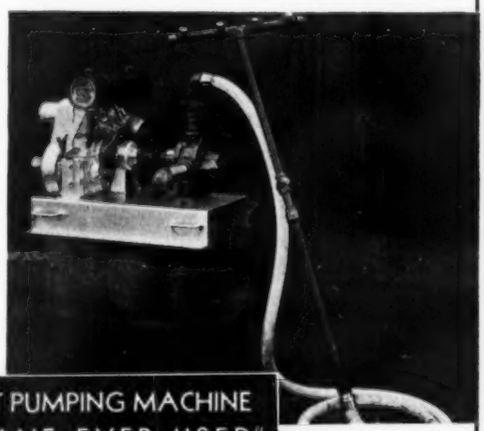
Be Sure Your Road Equipment is

PROPERLY POWERED

Roper Pressure Pumps are commanding the attention today of purchasers of Road Equipment everywhere. Road Scrapers, graders, drags, snow plows, bulldozers, truck lifts, concrete mixers, elevators, etc.—in fact, any equipment requiring hydraulic power transmission is always best equipped with

ROPER PRESSURE PUMPS

• for patching cracks in cement •



"THE BEST PUMPING MACHINE WE HAVE EVER USED"

says the superintendent of a State Highway Department about the Roper Pump used for pumping bituminous materials on the above concrete pavement crack patcher. Further particulars on request.

If you have a pumping job of any kind—general or special—get in touch with us. We are sure we can solve your pumping problems. Write today for further information.

GEO. D. ROPER CORP'N
Rockford, Illinois.

Please send Bulletin R5R and complete information concerning Roper Rotary Pumps.

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nishes the power, the crusher drive being by Multiplex V-belts. The countershaft is mounted on anti-friction self-aligning bearing provided with take-ups for V-belts driven from side-power take-off on tractor. All controls are operated from the driver's seat. The chassis is extra heavy weight I-beam frame, riveted, welded and bolted construction. The tractor used with the unit is either McCormick Deering, Allis-Chalmers or Case (industrial types).

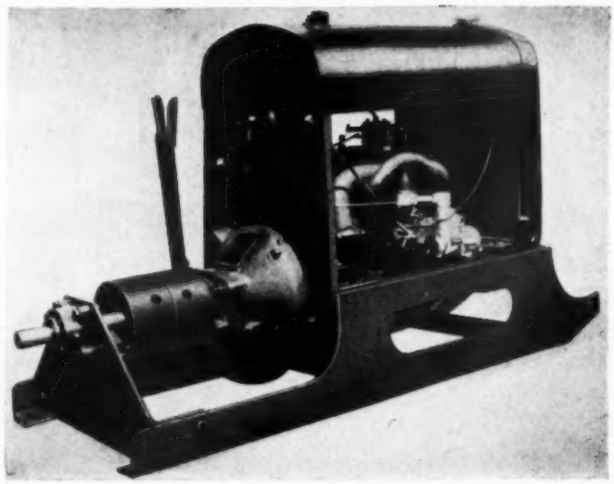
The hand feeding type of tractor-crusher unit has an overall length of 17½ ft., an overall width of 5½ ft., and an overall height of 5½ ft. The total weight of the unit with plain wheels is 8,350 lb. The wheelbase is 12 ft. 4 in., and the height of charging hopper is 4 ft. 3 in.

The unit also is furnished with a belt conveyor for feeding. A short bucket elevator can be mounted in place of the loading conveyor. The unit likewise can be supplied with a skip feed. A tractor trailer unit also is available.

Motor Stand

A motor stand adapted for many uses in the construction field is now being manufactured by the Southern Iron & Equipment Co., Atlanta, Ga. The stand is especially designed to mount the Model "A" Ford industrial motor. The stand is composed of practically all Ford parts, and can be serviced by any Ford dealer. The Standard Ford truck clutch is used, with a handle for clutch release, assuring easy and gradual starting of machinery.

The Spline shaft is made of high grade Maxel machine steel, and is supported by two No. A-7025 ball bearings, and especially constructed housings to fit these bearings. Gas tank is constructed of 14-gauge steel, is of 10-gal. capacity, and built in hood with a positive gravity feed to the carburetor, with fittings taking standard Ford fuel line connections. The brass fuel cap is designed to be locked. The top is of No. 14-gauge steel, and built as a unit with fuel tank and is heavy enough to give adequate protection to fuel compartment. The sides are standard Ford hood, parts altered to suit, and furnished only on special order.



Industrial Model "A" Motor Stand

The motor mountings are of heavy structural steel. The motor stand is made of structural steel and bolted throughout. No castings are used in this equipment, except bearing housings, for which there is no better material. Pulley 6 to 10 in. diameter can be furnished to take an 8 in. belt. The back panel has necessary slots for ammeter, coil, spark and gas control.

New Tractor Shovel

A new tractor shovel has been placed on the market by the Speeder Machinery Corporation, Cedar Rapids, Ia. The tractor is the "Caterpillar" Diesel 40 manufactured by the Caterpillar

Etnyre OREGON ILL.

This is an 850-gallon ETNYRE Model MO2C distributor spraying a 14-foot driveway.

Circulating spray bar with instantaneous shutoff at nozzles can be furnished up to 24 feet in width.

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May we suggest that you ask any Etnyre owner his experience before ordering your next distributor.

For complete literature, prices, and terms of payment write

E. D. ETNYRE AND COMPANY

Dealers in all principal cities.

350 Jefferson Street **Oregon, Illinois**

Yes—We would like you to mention ROADS AND STREETS.

Speeder Tractor Shovel

Tractor Company, Peoria, Ill. The shovel mechanism is manufactured and mounted on the tractor in the Speeder factory at Cedar Rapids.

Some of the features claimed for the Speeder Tractor Shovel are—All the mobility of a "Caterpillar" tractor; it travels at speeds upwards to nearly 5 miles an hour under its own power and will negotiate grades and ditches and soft ground the same as a tractor; very fast in operation; Speeder patented crowd for shovel operation; anti-friction bearings; extremely simple and extra heavy construction; easy one man operation.

The shovel boom length is 14 ft. and the dipper stick 11 ft.; crane and dragline booms are 22 ft. long.

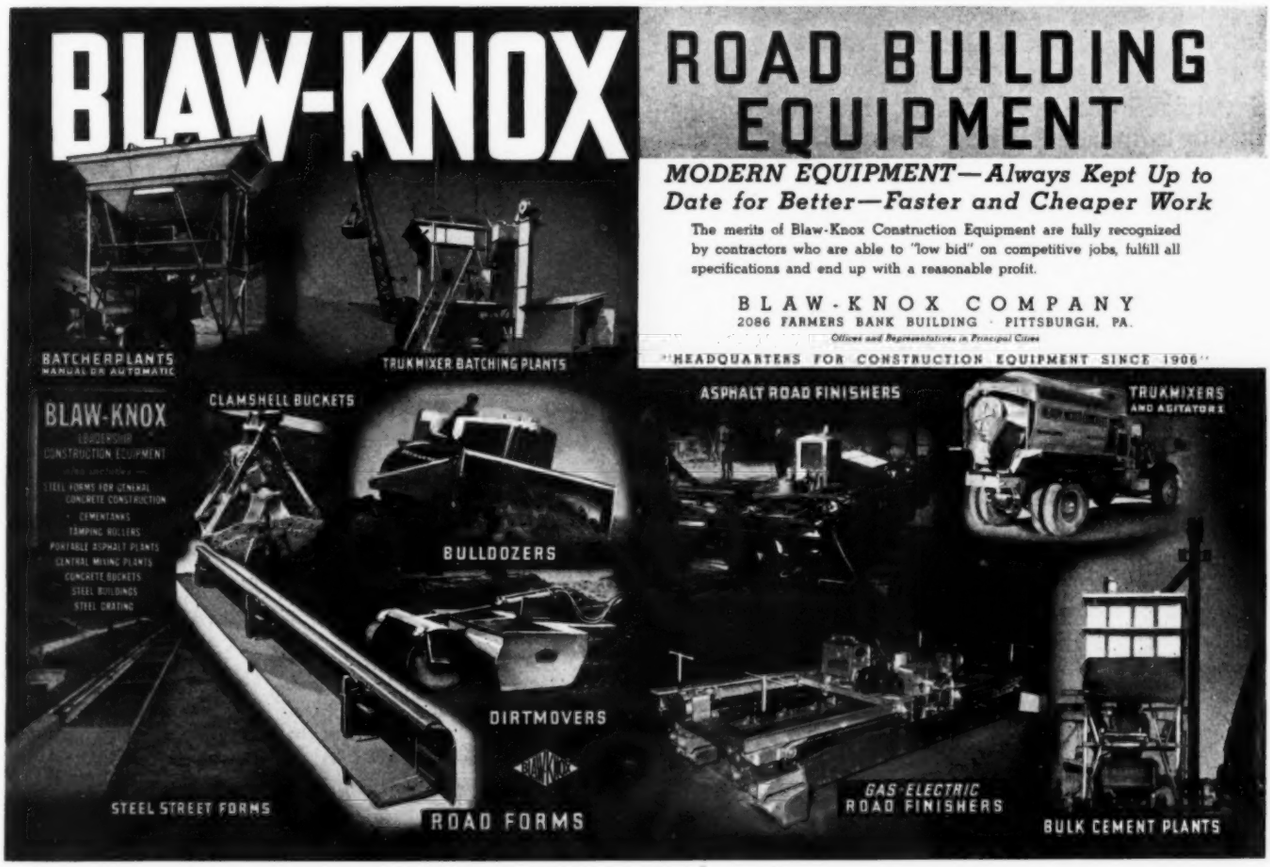
New Disc Grader Attachment

A disc grader attachment that fits on the moldboard of any make of motor patrol or road grader has been brought out by the Baker Mfg. Co., 506 Stanford Ave., Springfield, Ill. The attachment can be clamped on the moldboard in 15 or 20 minutes. The equipment is furnished ready to attach and nothing need be removed from the grader. The control of the disc attachment is by means of the regular grader blade controls.

The discs cut by shearing produced by down pressure, and the depth of the cut can be regulated.

The disc attachment weighs 1,000 lbs. The discs are set on an axle of chrome-molydenum steel. Timken thrust bearings are employed at each end of the axle. There is a ball bearing at the center. The discs are made of alloy, heat-treated steel with a tensile strength of 120,000 lbs. per square inch and are tough and long-wearing.

Baker Disc Grader Attachment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Our products find ready acceptance and our distributors are given wholehearted cooperation in their sales efforts, for despite adverse economic conditions, there has been no let-down in the high standard of quality established when our first product was introduced.

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Servicised Type "B" Joint

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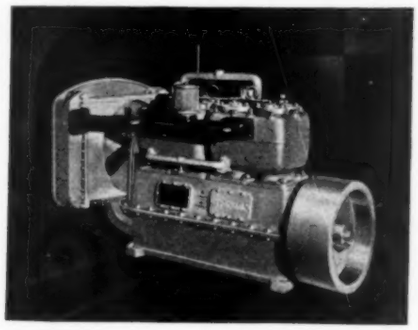
Tel. Grove Hill 0423

New 2-Stage Stationary Compressor

A recent addition to the compressor line of Schramm, Inc., West Chester, Pa., is a 2-stage stationary compressor. These compressors for belt and motor drive are built in five sizes. They are similar in design and operating features to the two-stage portable compressors.

They consist of low pressure and high pressure cylinders cast



Schramm 2-Stage Stationary Compressor

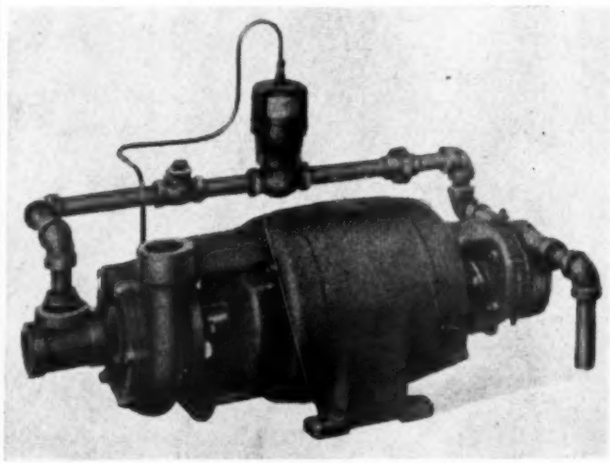
in one block. Air passing between stages enters a cross-flow type intercooler. This intercooler also effectively serves as a filter. The straightline construction of Schramm two-stage compressors is stated to provide an even distribution of wear on bearings and pistons. The Schramm detachable compressor block is embodied in the two stage compressor.

▼

Automatic Self-Priming Centrifugal Pump

An automatic self-priming Monobloc centrifugal pump, minus floats, hand operated valves, or re-circulation, has been developed by the Worthington Pump and Machinery Corporation, Harrison, N. J.

The problem of securing a truly dependable pump that would unfailingly prime itself when necessary was solved by Worthington engineers through the use of the Worthington-built Hytor, which is a positive primer, placed on the same shaft with the motor and pump. The only requirement is a reasonably tight suction line. When the pump—embodying the latest and most efficient impeller design—is primed, a pressure-operated cutout



Automatic Self-Priming Monobloc Centrifugal Pump

automatically unloads the Hytor. There is no re-circulation of water. There are no floats. Nor are there valves to set or give trouble. The priming apparatus has been exhaustively tested for 10,000 starts, equivalent to more than 30 years of operation under most service conditions.

The unit is exceptionally compact and neat, and is modern in appearance, with a sturdy splash-proof stream-lined motor, all on a symmetrical mounting. There are no unsightly tanks or float chambers. The pump is available for single or polyphase 50 or 60 cycle alternating current as well as for direct current operation.

Bucket Dump for Trucks

A bucket dump for trucks is a product of Dempster Brothers, Inc., Knoxville, Tenn. The dump may be dismounted at any time it becomes necessary to use the conventional type truck body. The detachable buckets which are only 28 in. high, are of heavy electric welded construction, suitable for withstanding rough treatment.

It is stated to be impossible to hoist the bucket too far or to drop it quickly, endangering the lives of workmen. When the bucket has reached sufficient height, the oil in hydraulic cylinder automatically by-passes. No brakes nor clutches are necessary. The bucket is dumped by engaging two extra heavy hooks provided for this purpose, which automatically drop into neutral position when the bucket is hoisted after being dumped. A semi-automatic, direct by-pass valve is provided for immediately

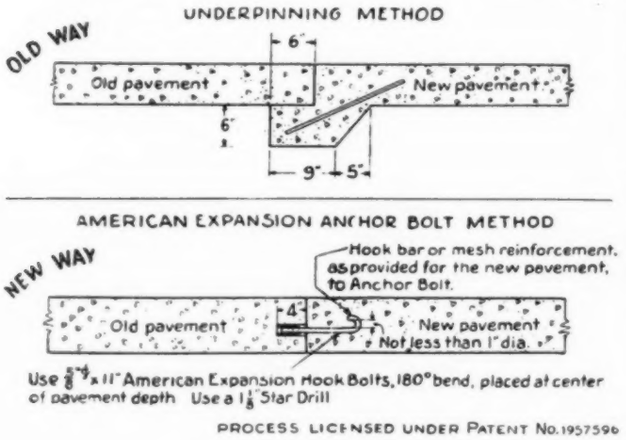
Dempster Bucket Dump

lowering the bucket to the ground, if desired. This valve is actuated by a lever at the driver's seat, and closed by spring action. No assistance is needed from outside help in completing the cycle after the detachable bucket is hooked to the dump.

▼

Tying Old Concrete to New

A new method of tying new concrete to the old concrete in widening or repairing concrete pavements has been developed by J. Warren Isett, President of the American Expansion Bolt


UNDERPINNING METHOD
OLD WAY
6"
Old pavement
New pavement
6"
9"
5"
AMERICAN EXPANSION ANCHOR BOLT METHOD
NEW WAY
Hook bar or mesh reinforcement, as provided for the new pavement, to Anchor Bolt.
Old pavement
4"
New pavement
Not less than 1" dia.
Use 5/8" x 11" American Expansion Hook Bolts, 180° bend, placed at center of pavement depth Use a 1 1/8" Star Drill
PROCESS LICENSED UNDER PATENT No. 1957596

Expansion Anchor Bolt Method

& Manufacturing Co., 108 North Jefferson St., Chicago, Ill. The method, which is patented, is shown in the accompanying illustration.

▼

Sullivan Moves General Offices

Sullivan Machinery Co. has changed the location of its general offices from the Wrigley Bldg., 400 North Michigan Ave., to the Bell Bldg., 307 North Michigan Ave.

Specify

TRINIDASCO

—cold-laid Asphalt Pavements

Trinidasco—the Native Lake asphalt mixture that is laid cold—is prepared with the same grades of stone, sand and other mineral aggregate and Trinidad Lake Asphalt used since 1876 in the construction of standard types of Trinidad hot-mix pavements.

Trinidad is the safest asphalt for durability. Trinidasco cold-laid pavements have a high coefficient of friction, and are safe for modern traffic.

Trinidasco cold-laid pavements are used for new construction . . . for resurfacing . . . for maintenance. Trinidasco is convenient . . . can be laid with hand tools or mechanical devices immediately after preparation, or from stock piles.

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Camp Glenloch

FOR GIRLS

Will help your daughter to a happy summer and a more secure future

On the Way to the Tennis Court

The purpose of this camp is to help girls find new ideals and to adjust themselves to generous living with others, to give them an opportunity to know and love life in the woods, and to guard their health. This is accomplished by means of carefully organized mental and physical activities.

Located on Lake Michigan 1½ miles through the woods from Pentwater, Michigan, this camp, personally owned and directed by Miss Miriam H. Wilson and permanently equipped, is now in its twelfth season.

There is, of course, the main building surrounded by well-screened modern cottages. They are open to the sun and fresh pine breeze but afford complete protection from the rain.

The fact that there are nine University trained women on the staff to help and guard the camp group limited to thirty, or practically one staff employe to each three girls, indicates the great care taken of the children. No girl may leave the camp grounds or go into the water without a counselor. The food is always of the best. Fresh vegetables and fruit are provided in abundance. The milk is pasteurized, the tested drinking water is excellent.

Program of Sports

SWIMMING

Swimming is especially stressed. The beautiful private beach on Lake Michigan is perfection — clean, white sand. Girls are tested and graded according to their skill in swimming, and are passed on to higher sections as rapidly as they qualify. Every precaution is taken for safety.

DRAMATICS

Dramatics to develop poise and ease of expression consist of informal dramatization of stories, impromptu camp fire entertainments and presentation of modern drama by the older girls.

HORSEBACK RIDING

Horseback riding under the management of an expert riding instructor who provides thoroughly trained horses *is included in the general fee.*

GENERAL

Instruction is given in tennis, it being one of the popular sports. Of course, there are hikes through the woods over the old logging roads, campfires, study of birds, flowers and trees, photography, handcraft, group sings, special picnics, and last but far from least, the canoes and row boats especially for the older members.

An Old Trail

The highest awards of all are given at the close of camp to those girls who, throughout the camp period, have exemplified the camp spirit—kindly and generous living with others—and who have steadfastly clung to character ideals.

Honors are also given for swimming, tennis, etc., but these are secondary.

The whole program is designed to keep the children alive mentally and physically and is so presented that every day brings fresh treats and thrills of new discoveries.

This year, to meet present conditions, the general fee will be $175 for the eight weeks' season starting June 27. The old charge was $275. Notwithstanding the lower rate, the same high standards of instruction, food, equipment, etc., will be maintained. It is truly a depression bargain in happiness and character building.

Miss M. H. Wilson,
5702 Kimbark Ave.,
Chicago, Ill.

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Address .....

City .....

State .....

Telephone Dorchester 1810

Write to Miss M. H. Wilson, 5702 Kimbark for booklet

● "Daily production was 2052 yds. . . . on 27 gals. of Diesel fuel in 8 hrs". . . "Operated shovel 240 hrs. on 850 gals. of fuel oil". . . "We averaged 2000 yds. in 10 hrs. . . . at a fuel cost of $2.55". . . "We find the Diesel shovel has more power, travels and swings faster" . . . "Our production justified your claim of 10% increased production" . . . "I'd say 20% was not far off because the harder the digging, the easier it is for this machine to increase this percentage". . .

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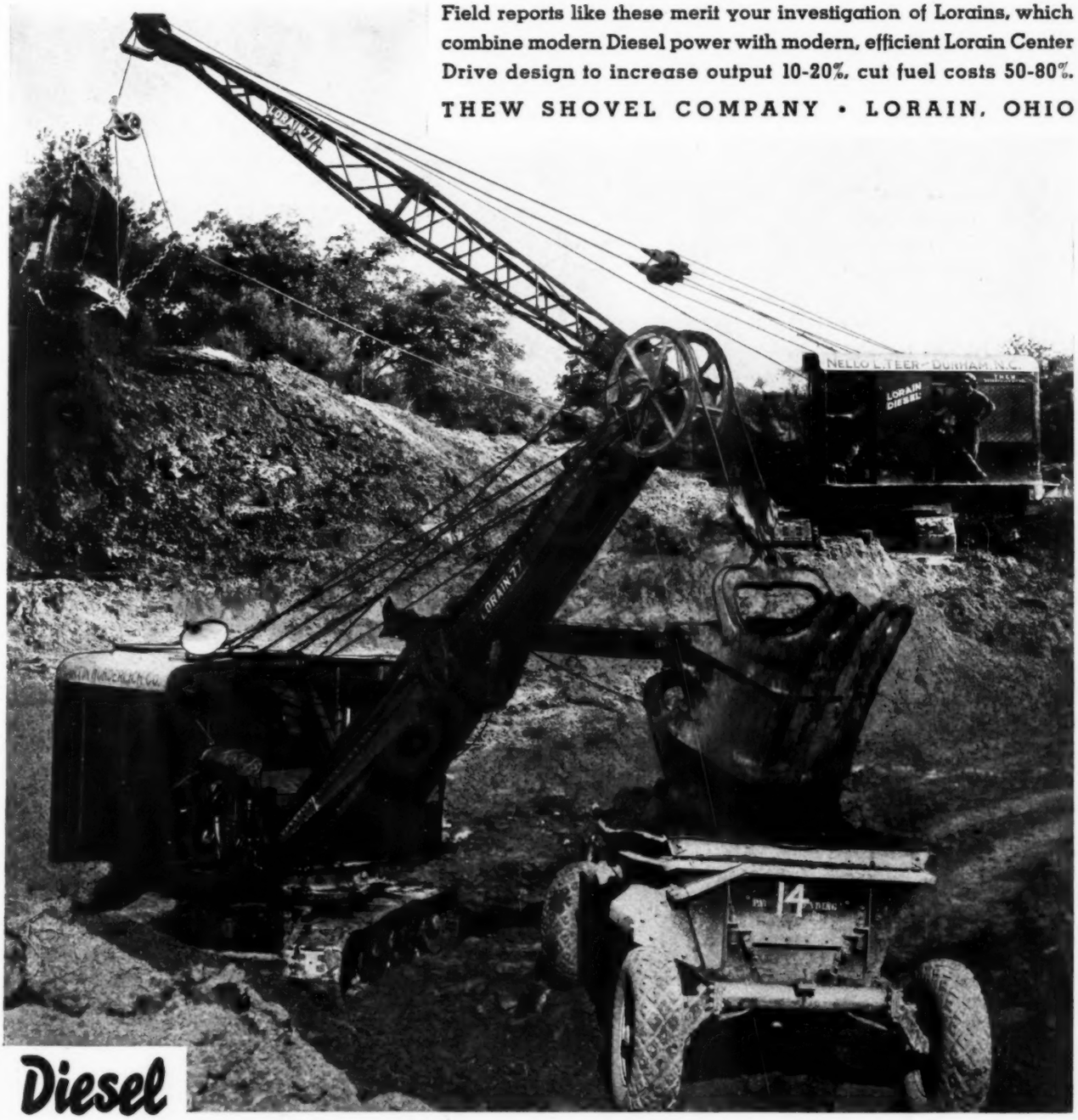

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WRITE for our new circular showing illustration and description of Olsen Special Bench Type Compression Testing Machine. It is designed especially for testing 2" x 4" cylinders and 2" x 2" cubes. The machine is hydraulic, having two gauges, one to half and the other to full capacity. Capacity ranges of from 20,000 to 80,000 lbs.

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